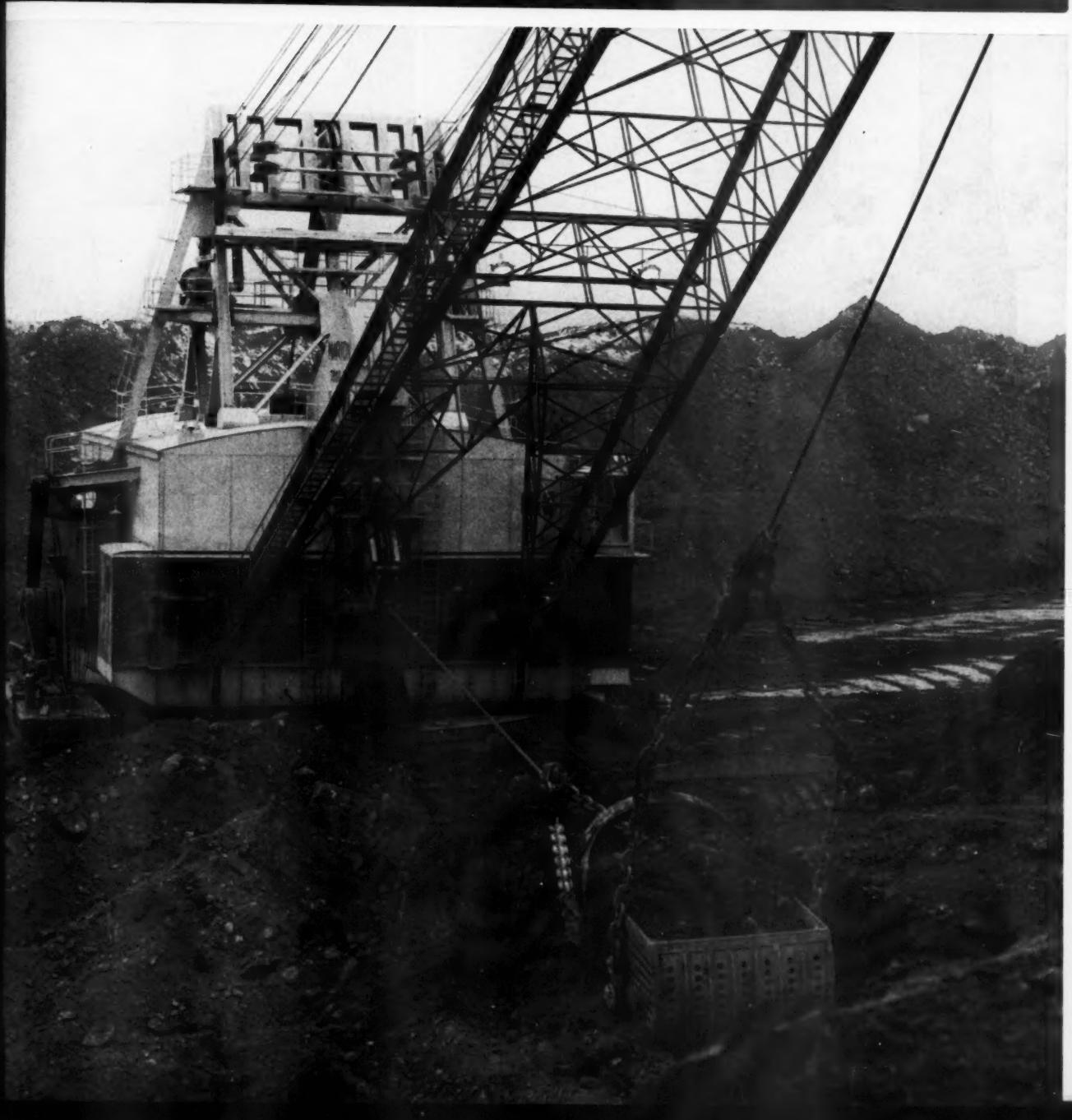
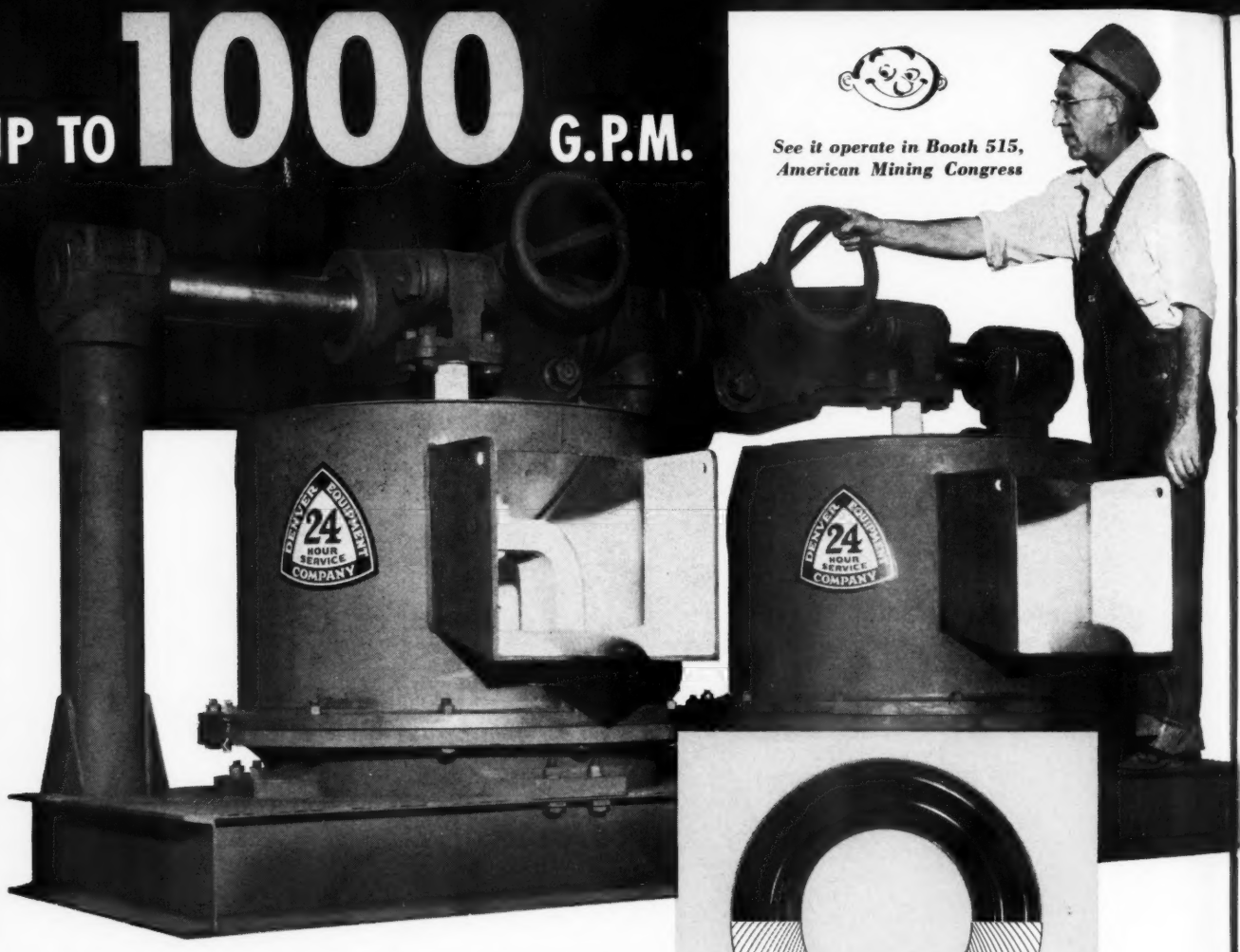
MINING CONGRESS JOURNAL

SEPTEMBER 1958



UP TO 1000 G.P.M.

See it operate in Booth 515, American Mining Congress



DENVER
ADJUSTABLE STROKE DIAPHRAGM PUMP

...now available in a full range of sizes, from 1" Simplex to 10" Duplex, capacities from 2½ to 1000 g.p.m. and with these distinctive design and operating features:

- Anti-friction bearing design practically eliminates friction—cuts horsepower requirements.
- Simplified drive uses standard motor with V-Belt drive to oil-immersed worm gear reduction unit.
- Improved, hand-wheel adjustment changes length of stroke, alters pulp flow *while pump is operating.*

For pumping filtrates, metering flotation feed or regulating thickener underflow, the new DECO pump offers you economical, high capacity, low maintenance pumping. For full details, write for Bulletin P8-B12.

HEART OF THE PUMP IS THIS NEW, IMPROVED DIAPHRAGM

- New, improved design makes possible longer stroke plus up to 75% higher capacity.
- Tough rubber diaphragm has patented spiral nylon cord construction that allows constant flexing of diaphragm. It is highly superior to common crossed-strand construction of ordinary diaphragms.
- Exclusive curvature of diaphragm follows true catenary curve — distributes flexing stresses, overcomes destructive kinking action, prolongs diaphragm service life.
- Molded rim is clamped in place. No holes to weaken diaphragm. Distributes tension evenly to entire circumference. Fast, simple replacement.

"The firm that makes its friends happier, healthier and wealthier"

DECO ENGINEERED

DENVER EQUIPMENT 24 HOUR SERVICE COMPANY

Complete Mill Equipment

DENVER EQUIPMENT COMPANY

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MINING CONGRESS JOURNAL

VOL. 44 SEPTEMBER 1958 NO. 9

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CONTENTS

Opinions expressed by authors within these pages are their own and do not necessarily represent those of the American Mining Congress.

ARTICLES

DEPARTMENTS

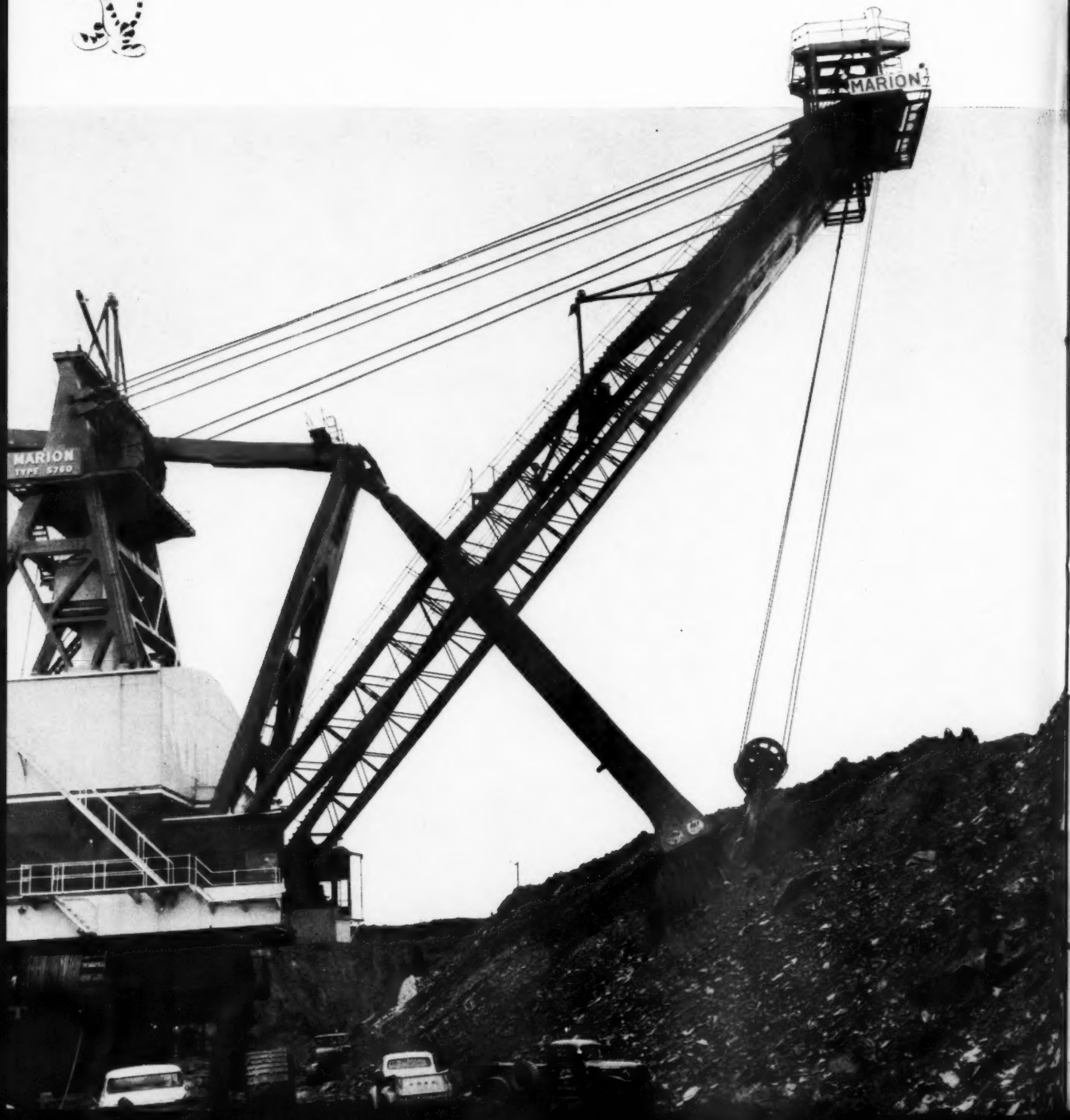
ON OUR COVER

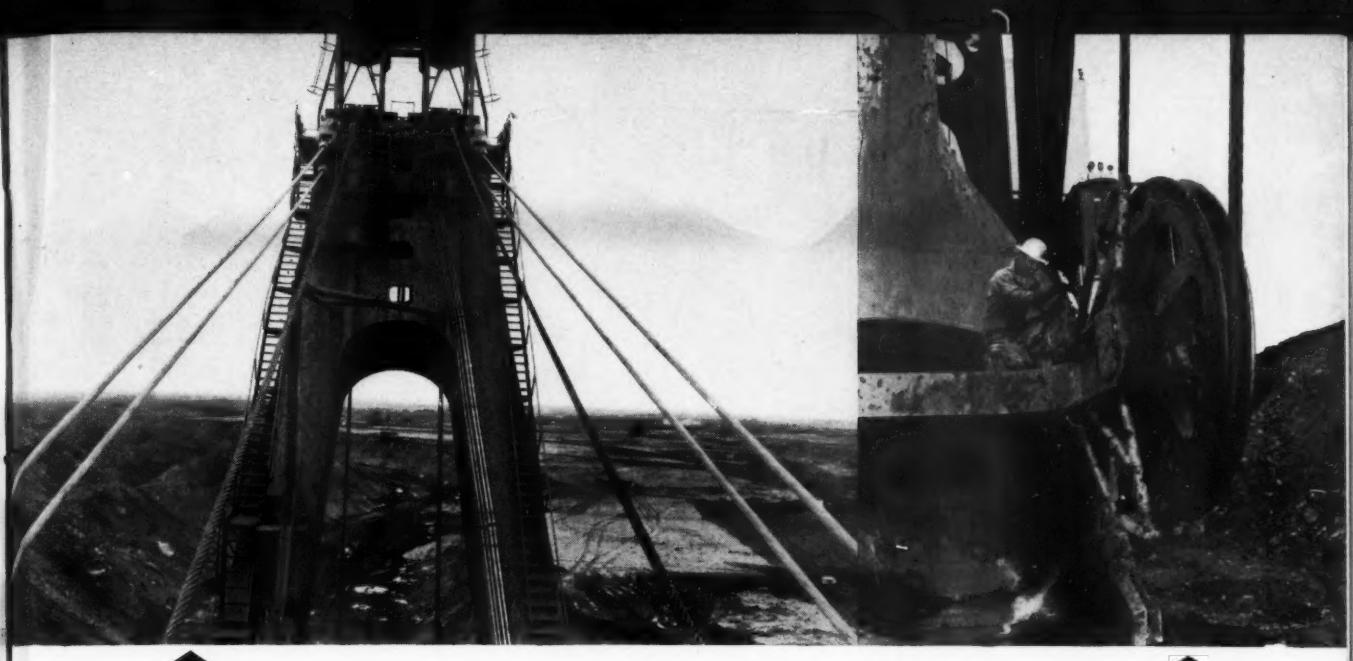
Central Ohio Coal Company's Muskingum Mine, located on a hilly 35,000-acre tract between McConnelsville and Beverly, Ohio, utilizes a walking dragline that carries a 220-ft boom and a 35-yd bucket

Published Monthly. Yearly subscriptions, United States, Canada, Central and South America, $3.00. Foreign, $5.00. Single copies, $0.30. February Annual Review Issue, $1.25. Entered as Second-class Matter, January 30, 1915, at the Post Office at Washington, D. C.

Another "biggest" shovel flexes its wire rope muscles

...they're Tiger Brand, of course !





The giant boom towers 147½ feet from the ground and is supported by four 3⅝-inch Tiger Brand Galvanized Boom Supports designed to resist vibration and give long service life.

Two Tiger Brand hoist ropes, 2⅝ inches in diameter, do the heavy lifting. It is estimated that about 60,000 yards of overburden is being moved per 24-hour day. Coal production is expected to be 4,000 tons daily.

Put yourself into this picture for a minute. You are holding on to a railing 103 feet up in the "crow's nest" of one of the world's three largest shovels.

Just below you, the 2⅝-inch hoist ropes whirl through sheaves as the dipper rams into the hillside. You feel the big machine shudder as it scoops up 100 tons of rock and dirt. Then you swing with the load and see it dumped 96 feet high and 100 yards away. You wonder how the wire ropes that seem so small can lift so much.

The answer to that goes back to steelmaking and wire rope engineering. These USS Tiger Brand Ropes are specially designed for big shovels. They have been used on the Mountaineer, River Queen, and Coal Chief—with outstanding success.

The huge boom is supported by four 3⅝-inch-diameter USS Tiger Brand Galvanized Boom Support Strands 105½ feet long. Each strand has a catalog strength of 768 tons, for a total strength of 3,072 tons.

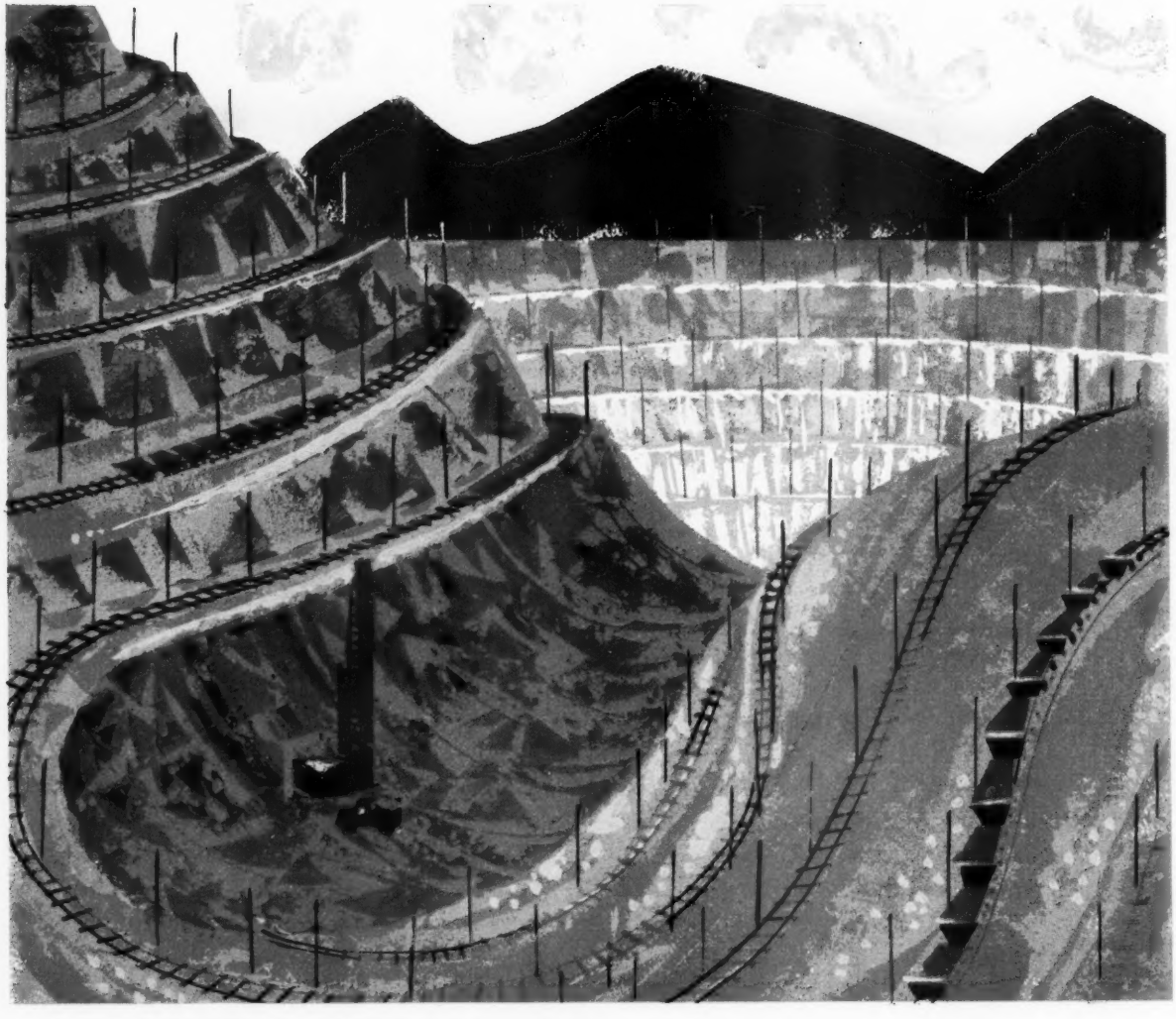
Your equipment may not need such large wire rope, but the same quality of engineering that goes into these big shovel ropes is applied to all sizes of USS American Tiger Brand. For more information, write American Steel & Wire, Rockefeller Building, Cleveland 13, Ohio.

USS and Tiger Brand are registered trademarks

American Steel & Wire Division of USS **United States Steel**

Columbia-Geneva Steel Division, San Francisco, Pacific Coast Distributors • Tennessee Coal & Iron Division, Fairfield, Ala., Southern Distributors • United States Steel Export Company, Distributors Abroad

Another 70-cu.-yd. shovel. Built by Marion Power Shovel Company for the Victoria Mine of Midland Collieries, Inc., subsidiary of Midland Electric Coal Corporation. The Victoria Mine is located near Galesburg, Ill.



PIT MINE OR QUARRY... CYANAMID EXPLOSIVES GET RIGHT DOWN TO PAY-DIRT!

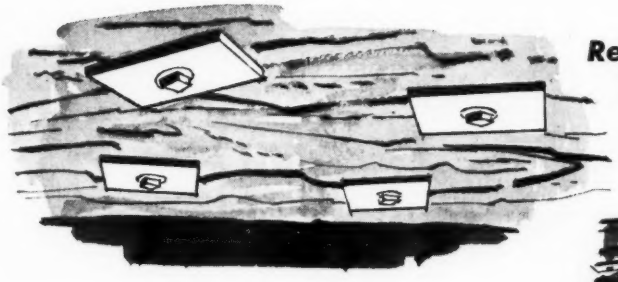
In overburden, ore body or rock, blasting efficiency is achieved only when every shot is carefully studied and properly designed ...using a high-quality explosive that is exactly suited to do the job. Cyanamid's complete line of explosives and our experienced staff offer you every technical service... plus speedy delivery right to your operation. For more information, just call your Cyanamid Representative, or write to AMERICAN CYANAMID COMPANY, EXPLOSIVES AND MINING CHEMICALS DEPARTMENT, 30 Rockefeller Plaza, New York 20, New York.

This effective shot was made with Cyanamid explosives in hard limestone at a typical quarry. Fragmentation is perfect for loading, hauling and crushing.

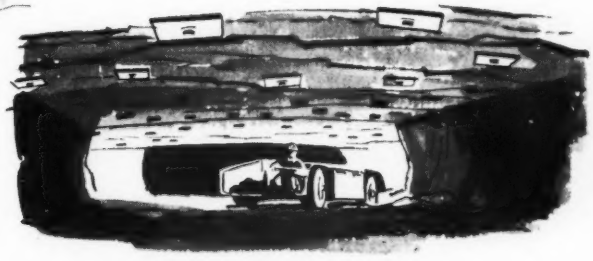
CYANAMID

DISTRICT SALES OFFICES: St. Louis, Missouri • New York City, New York • Latrobe, Pennsylvania • Pottsville, Pennsylvania • Scranton, Pennsylvania Dallas, Texas • Salt Lake City, Utah • Bluefield, West Virginia. **THE CYANAMID LINE:** High Explosives • Permissibles • Seismograph Explosives Blasting Agents • Blasting Powder • Blasting Caps • Electric Blasting Caps • Blasting Accessories.

Here's why it pays to bolt your roof

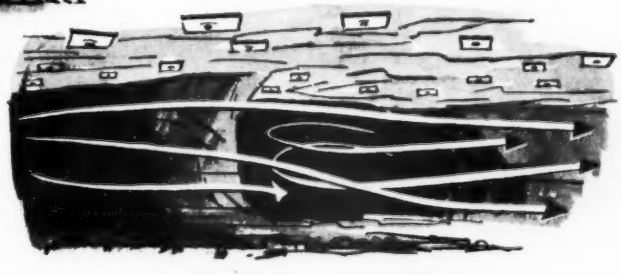


Reduces rock falls . . . improves safety



Permits wide haulageways . . . increases clearance

Makes mechanized equipment easier to maneuver



Improves ventilation . . . no bulky supports to store

With roof bolting, mechanized equipment can be worked close to the face, due to the absence of bulky supports. In addition to permitting wide openings and clearances, roof bolting also improves ventilation . . . minimizes the need for storage space . . . eliminates fire hazards.

Bethlehem Headed Roof Bolts In 3 Diameters

To meet virtually every roof condition, Bethlehem makes headed roof bolts in 3 diameters: $\frac{5}{8}$ in., $\frac{3}{4}$ in., and $\frac{7}{8}$ in., having typical breaking loads of from 24,000 lb for the $\frac{5}{8}$-in. bolt to 45,000 lb for the $\frac{7}{8}$-in. bolt.

If you'd like to know more about roof bolting, write us at Bethlehem, Pa., and we'll have a representative call at your convenience.

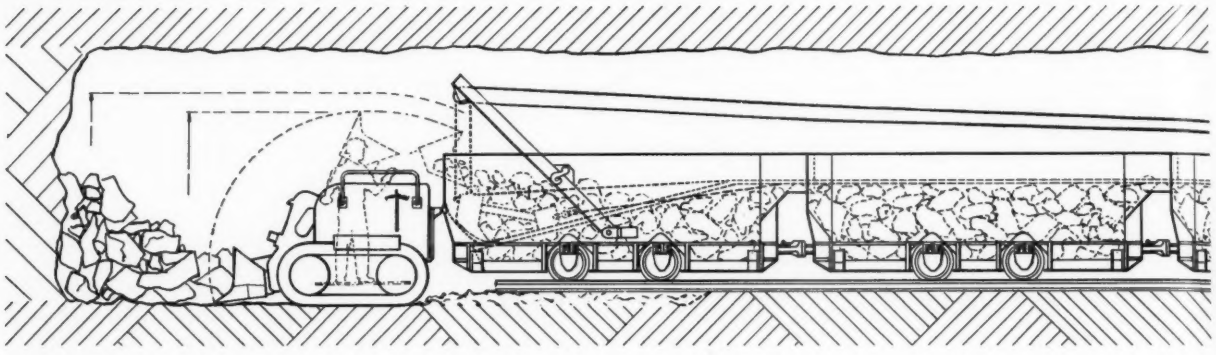
SLOTTED BOLTS, TOO. For use in certain types of rock, Bethlehem also makes a 1-in. slotted roof bolt, which is used with a steel wedge. Ask for details.

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA. On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation. *Export Distributor:* Bethlehem Steel Export Corporation

BETHLEHEM STEEL

BETHLEHEM STEEL

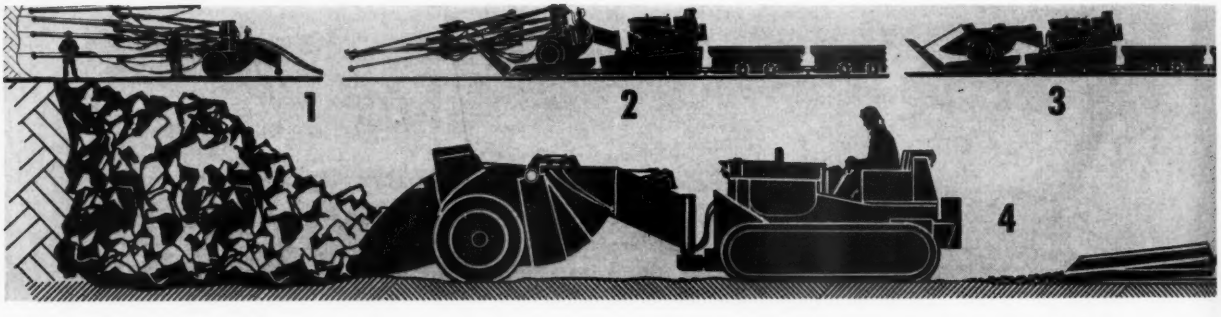
NEW S-D SLUSHER-TRAIN Promises You



"High-Ball-it" Speed and Safety Will Save You Days . . . Weeks

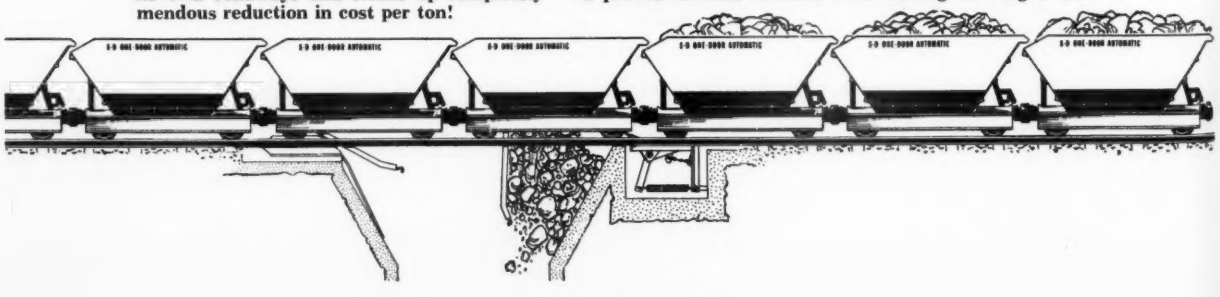
Here is what you have: (1) Equipment — Loader, S-D Slusher-Train and locomotive. (2) Men — only two . . . the loader operator and the S-D Slusher-Train operator, who becomes motorman when S-D Slusher-Train is in transit. Train is made up of S-D Automatic Bottom Dumping cars of any required number to give you the capacity to hold an entire round. Cars are not dumped until round is mucked-out and ready for next operation, drilling or timbering. There is no car switching, and no extra men required. Cars feature S-D, exclusive overlapping ends. You can figure on mucking out 1 to 1½ tons a minute. S-D Slusher-Train moves into face and remains stationary until entire round is mucked-out. Train is dumped by means of simple S-D Automatic tripping and closing devices. You obtain high speed mucking with less equipment, requiring less maintenance and fewer men. You get the muck out faster so you can start drilling again — saving days, sometimes weeks with fewer men in driving tunnels . . . obtaining tremendous savings in man-hours, maintenance and time! AND, same cars used in development can be used for production haulage!

S-D SLUSHER-TRAIN AND S-D GISMO® FEATURED

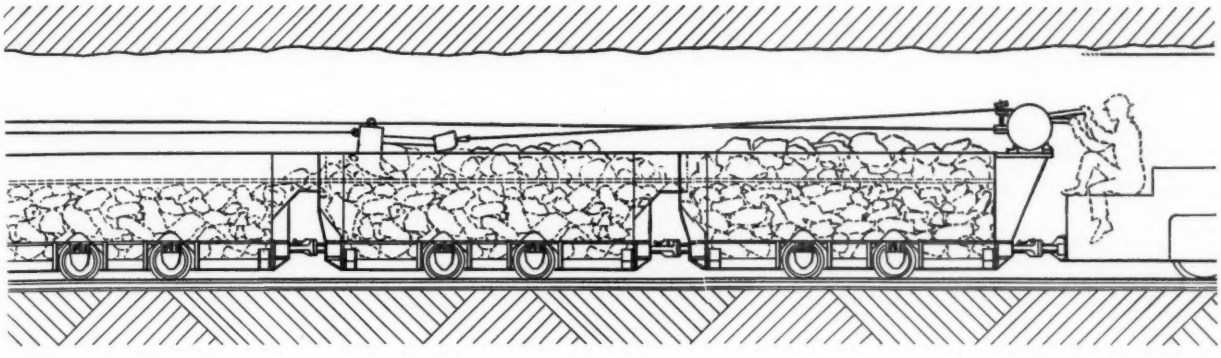


NEW ALL-PNEUMATIC-TIRED GISMO TRANSLOADER EXHIBITED

If you are attending the Mining Show at San Francisco Sept. 22-25, our Booth 840 offers you an excellent opportunity to investigate to your satisfaction the large savings available to you by operating with S-D SLUSHER-TRAINS . . . S-D GISMO . . . and new S-D GISMO TRANSLOADER. The Gismo equipment offers you a self-loading transport that loads (mucks) in development or production . . . transports . . . supports 2 to 5 job-mounted drills . . . back fills . . . moves boulder rocks . . . makes its own roadways and cleans up completely — a proved method of hard rock mining offering a tremendous reduction in cost per ton!



Tremendous Savings in Tunnel Driving



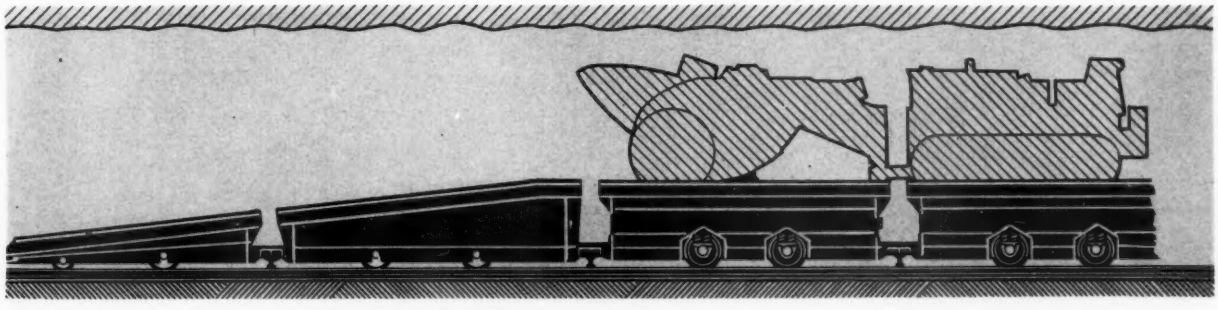
of time and Costs in Completing Jobs, based on today's Methods

The Gismo Ramp Car method is your answer to low-cost tunnel driving where larger cross sections are being driven, especially where a haulage drift is being driven in ore zone. In this way train can be loaded by the Gismo Self-Loading Transport without installation of ramp, chutes, etc. Regardless of which equipment best meets your requirements, S-D Slusher-Train, S-D Gismo or new S-D Gismo transloader the cars also become the most economical method for production haulage.

Illustrations show:

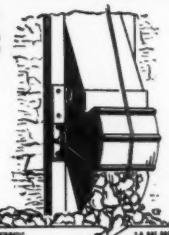
1. **The Gismo Drilling Jumbo moves in to drill out a round with 4 drills operated by a two-man crew.**
2. **Drilling completed, Gismo Jumbo pulls out from face to ramp cars for transfer to another heading or side-track.**
3. **In the meantime, rock has been blasted at the previously drilled face and Gismo Self-Loading Transport is brought in for mucking and transporting operation.**
4. **While Gismo is mucking at the previously blasted round, loading cars one-after-another, the Drilling Jumbo can be set up at another heading in multiple heading development.**

AT SAN FRANCISCO MINING SHOW SEPT. 22-25



S-D OVERLAPPING END ONE-DOOR AUTOMATIC

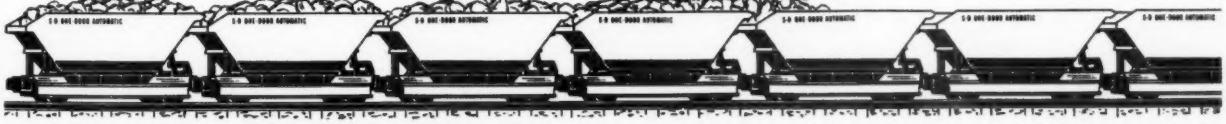
Gives you greater capacity for same overall dimensions . . . better trackability . . . low center of gravity . . . wide door opening . . . clean shedding . . . simple and low cost dump facility . . . ruggedness of design.



PREVENTS SPILLAGE

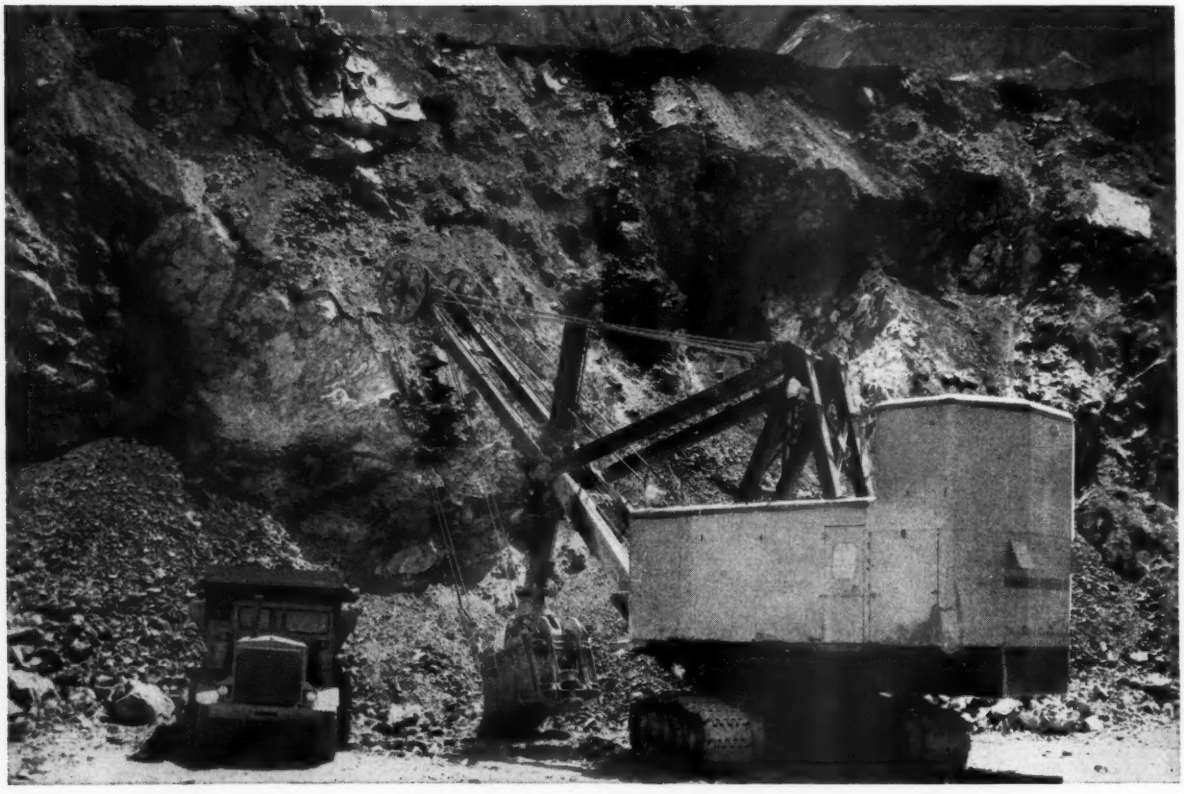
For complete information on S-D Slusher-Trains, S-D Gismo Equipment and S-D Mine Cars write us today.

Sanford-Day Iron Works, Inc.
Knoxville, Tennessee



SANFORD-DAY KNOXVILLE, TENNESSEE

ESCO POINTS and ADAPTERS MOVE 35 MILLION CUBIC YARDS ON SP SALT LAKE CAUSEWAY



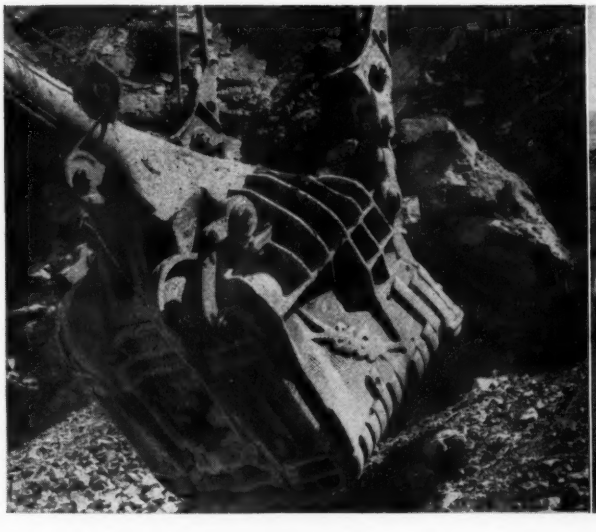
ESCO points and wearcap adapters on M-K's dippers are quarrying the 35 million cubic yards of fill material for the mammoth causeway.

EVERY *ESCO* POINT IS BRINELL TESTED TO ASSURE THE MAXIMUM DEGREE OF ABRASION-RESISTANCE HARDNESS AND LONG LIFE

SEVERE DIGGING CONDITIONS EXPERIENCED

Shovel operators and mechanics, veterans in all types of rock excavation, say they have never experienced such severe digging conditions as the high silica content quartz being quarried by Morrison-Knudsen Company for the 13-mile long Great Salt Lake railroad crossing of the Southern Pacific Railroad.

Increased point wear caused by this highly abrasive material makes the quick-change feature of *ESCO* points an important factor in keeping downtime to an absolute minimum. Easy-to-change *ESCO* points save at least half the time required in replacing bolt-on teeth.



ESCO Cast 12M Points and Adapters Cut Costs 4 Ways:

1. Quick-Change design reduces downtime. Four *ESCO* points can be removed and replaced in only five minutes.
2. *ESCO* points are quickly available for every digging tool from one convenient source.
3. Points feature self-sharpening design. There are eight point shapes to choose from.
4. Cast design permits extra metal at wear points. Points are heat treated and differentially hardened for long life.

See your nearest *ESCO* dealer. Ask for *ESCO* Tested Points Catalog No. 187.

ESCO®

ELECTRIC STEEL FOUNDRY COMPANY

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MFG. PLANTS AT PORTLAND, ORE. AND DANVILLE, ILL.

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Euclid Rear-Dumps give you bonus benefits

For 25 years Euclid has specialized in designing and building equipment for heavy, off-highway earthmoving. The dependable low cost performance of these "Eucs" has made them the standard of comparison for contractors, mines and quarries around the world. About 7 of every 10 off-highway Rear-Dumps are Euclids.

Although this unmatched experience may not be apparent when comparing specifications, it assures bonus benefits for Euclid owners—cost-cutting advantages not provided by comparable equipment. The greater use of Euclids results in faster complete field exposure to operating and maintenance characteristics under all conditions. It assures advanced design that pays off in more work-ability and minimum downtime on the job.

With Euclid's larger machine population, it's economically possible for Euclid dealers to provide more complete service facilities and ready availability of all factory engineered replacement parts. It's factors like these that enable owners to keep their "Eucs" operating at peak efficiency with unusually high availability and low production cost.

When you're considering Rear-Dumps, get facts and figures from your Euclid dealer—have him show you why ***Euclids are your best investment.***

EUCLID DIVISION GENERAL MOTORS CORPORATION, Cleveland 17, Ohio

Your Euclid Dealer offers the best equipment investment

GM GENERAL MOTORS EUCLID

EUCLID EQUIPMENT

FOR MOVING EARTH, ROCK, COAL AND ORE

Figure the true cost of cable—and you'll see why Anaconda Shuttle Car Cable costs you less!

The cost of your shuttle car cable includes more than just its original price. For example . . .

A shuttle car cable failure slows down all production in a section—involving perhaps a quarter of a million dollars' worth of equipment—for the 20 to 30 minutes it takes to find and make the repair. Each failure means a loss of approximately $90 on top of this—for materials, direct labor, etc.

And at $90 each it takes only a few failures to add up to the cost of a new cable!

According to one company's records the failure of other brands of shuttle car cable was *six times greater than for Anaconda cable*—during the same period of time and under the same working conditions.

WHICH CABLE COSTS LESS?

The Man from Anaconda, or your Anaconda distributor will be glad to work with you to lower the cost of shuttle car cable failures in your mine. See him today. Write for new Bulletin DM-5815, Anaconda Securityflex Portable Cables for the Mining Industry, Anaconda Wire & Cable Company, 25 Broadway, New York 4, N. Y.

58321

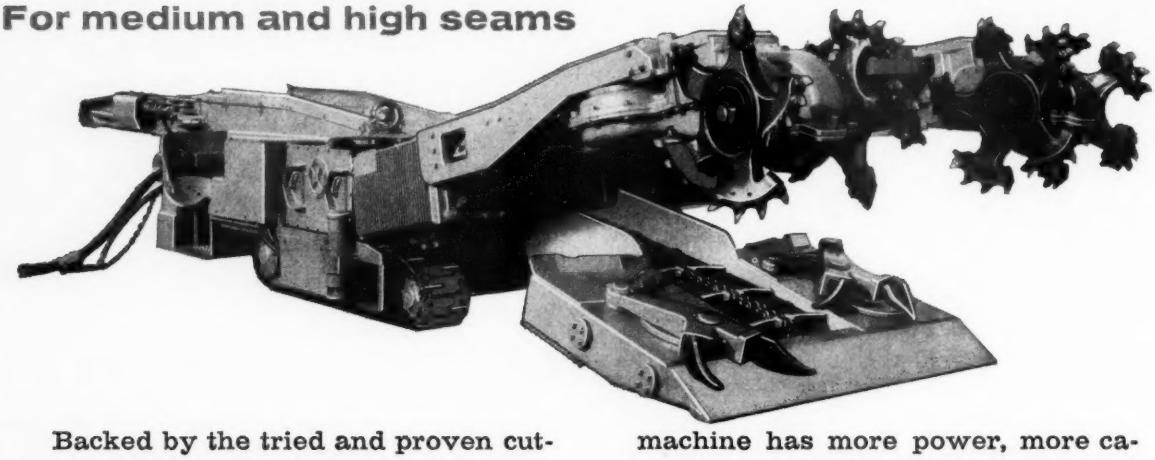
LIVE BETTER ELECTRICALLY

SEE YOUR **ANACONDA®** DISTRIBUTOR FOR **SHUTTLE CAR CABLE**

More tonnage . . . more profits

50% Higher Tonnage with the *new* CM37

For medium and high seams



Backed by the tried and proven cutting principle of the original Lee-Norse Miners, the CM37 brings a new high in operational efficiency to continuous mining. This rugged machine has more power, more capacity and higher tramming speed that results in increased tonnage per man shift.

Check these NEW FEATURES!

1. **Total weight 25 tons—a 25% increase! Extra weight mostly in improved cutter head where it does the most good!**
2. **More power—fewer motors! Only 3 identical electric motors used . . . conservative continuous ratings . . . no water cooling.**
3. **Heavy duty electric control.**
4. **14" wide crawler treads with improved hydraulic motor and gearing.**
5. **24" wide conveyor driven by hydraulic gear motors applied directly to gathering head. Hydraulic start and stop . . . no clutch required.**
6. **Multiple tramming speeds—variable speeds to 50 feet per minute . . . fast tramming at 90-100 feet per minute.**
7. **Increased capacity...4 to 5 TONS PER MINUTE.**

Coal high or low? . . .

. . . with Lee-Norse MINERS

For Low Coal . . .

LCM28

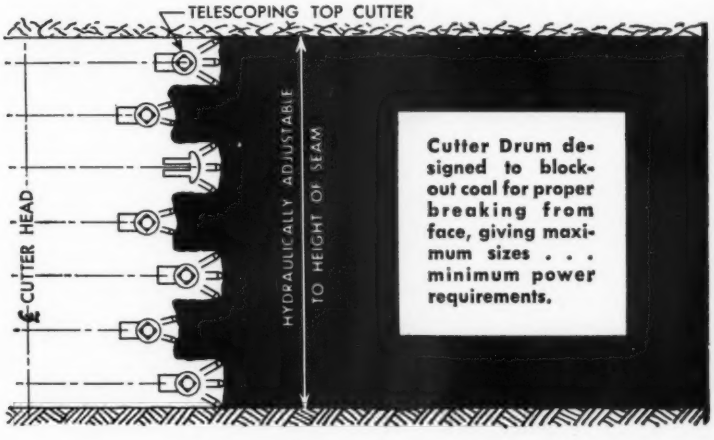
ready for production!

For seams 30" to 48"

Here's how LCM28 *produces profitable tonnage!*

1. Weight 16 tons — rugged and heavy enough to cope with tough cutting conditions.
2. Capacity—2 to 3 tons per minute.
3. Hydraulically driven 24" flexible Conveyor.
4. Two Cutter Heads cut a wide face 16 feet or less.
5. Dual gathering arms have maximum reach of 11 feet . . . will gather ALL the coal regardless of position.
6. Controlled Tramming Speed gives proper sumping action and Dual Pump combination gives high tramming speed.
7. Especially good in cross-cut development!

The LCM28 "Low Coal" Miner employs a new combination of cutting and gathering coal. The vertical mounted extendable cutter drums arc together like a "clam shell."



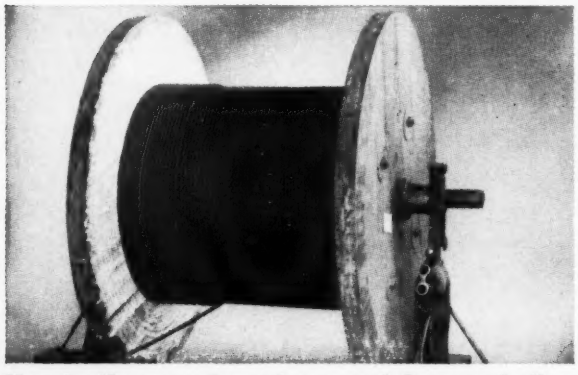
All Lee-Norse Miners are available in AC or DC power.

Lee-Norse Company
CHARLEROI, PENNA.
Specialists in Coal Mining Equipment

Lee-Norse MINERS keep production on the go!

Tuffy® Wire Rope

How to Get Longer Service from Wire Rope: Proper Unwinding, Socketing, Seizing, Clipping

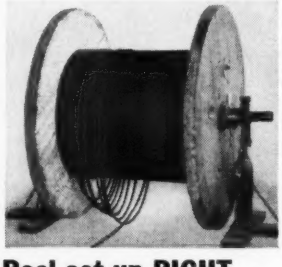


Here's the way to set up reel for unwinding

The stock reel should be set up on jacks, so the rope will come from the under side of the reel as shown in this picture.

Reel set up WRONG

The rope is coming from the top of the reel and forming loops as the reel over-runs. These loops are likely to form kinks and dog-legs, which can be ruinous to rope life.



Reel set up RIGHT

Unwinding has started, and the reel is spinning faster than the rope is being pulled off. But because it's coming from the under side of the reel, the rope is simply loosening on the reel, with no damage.

Simple way for PROPER SEIZING

Since practically all wire ropes today are preformed, we suggest that when cutting you put only one seizing on each side of the cut.

For ropes other than preformed, *three* seizings should be used on each side of the cut so there will be no misplacement or relative movement of strands. *Four* seizings on each side are required for a lang lay rope, or any rope having an independent wire rope core or a wire strand core. *Four* seizings are also needed for all 18x7 ropes, and all ropes larger than 1" diameter.

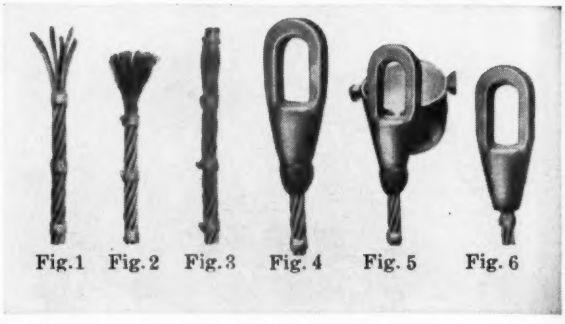


Fig. 1 Fig. 2 Fig. 3 Fig. 4 Fig. 5 Fig. 6

Nine Steps of Correct SOCKETING

1. Securely seize and serve with soft wire ties before cutting, and have at least two additional seizings placed at a distance from the end equal to the length of the basket of the socket.

2. When the rope is properly seized, take off the end seizing. Cut the fiber center back to the seizing, as shown in Fig. 1 above. Untwist and broom out the wires. See Fig. 2.

3. Clean the wires for the distance they are to be inserted in the socket. Use benzine, naphtha, gasoline or other solvent. Then wash off in boiling water or boiling ammonium chloride used in Step 5.

4. Then dip cleaned wires in commercial muriatic acid to a depth not greater than ¾ of the cleaned length of wire. Keep the wires immersed for 3 minutes, or until the acid has thoroughly etched each wire. Be sure acid does not contact any other portion of rope.

5. Immerse wires into boiling ammonium chloride. A white coating will be left on the wires.

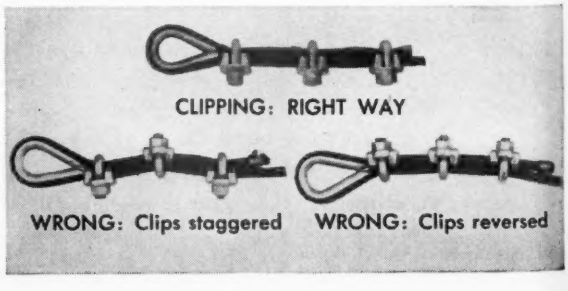
6. Place a temporary tie wire over the ends of the cleaned wire (see Fig. 3). Be careful not to get the cleaned wires greasy or oily.

7. Insert the rope end into bottom of socket. Remove temporary tie wire.

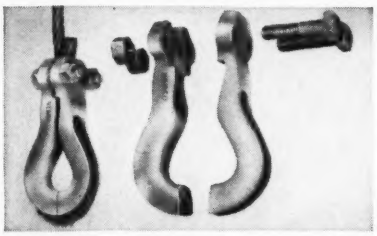
8. Holding the rope vertically in a vise, set the socket so that the wires are flush with top of the socket basket and seal the bottom with putty or clay (Fig. 4). Pour in among the wires about ½ teaspoon of sal ammoniac crystals.

9. Pour molten zinc into the basket to fill (Fig. 5). When zinc is solidified, remove seal. Socketing is complete as shown in Fig. 6.

58-3



Tips

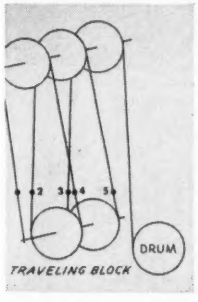


Be sure to use right FITTINGS

The fitting you use on wire rope can handicap it or enable it to work at full efficiency. Fittings which derive holding power from crimping action are harmful to the rope.

Shown here is a clamp that has no wrong side—can be put on either way. It snugly saddles the rope, grips larger surface area in such a way that loads are carried almost solely by friction rather than by crimping action. Combined in its two parts is a thimble and the parts are interlocking to prevent collapse of the thimble and to eliminate all shear on the bolts.

How to figure REEVING loads



Reeving ropes through the sheaves multiplies the number of parts supporting the load. The lead line to the drum carries the weight of the load lifted, divided by the number of parts of line supporting load, plus the accumulation of friction on all sheaves.

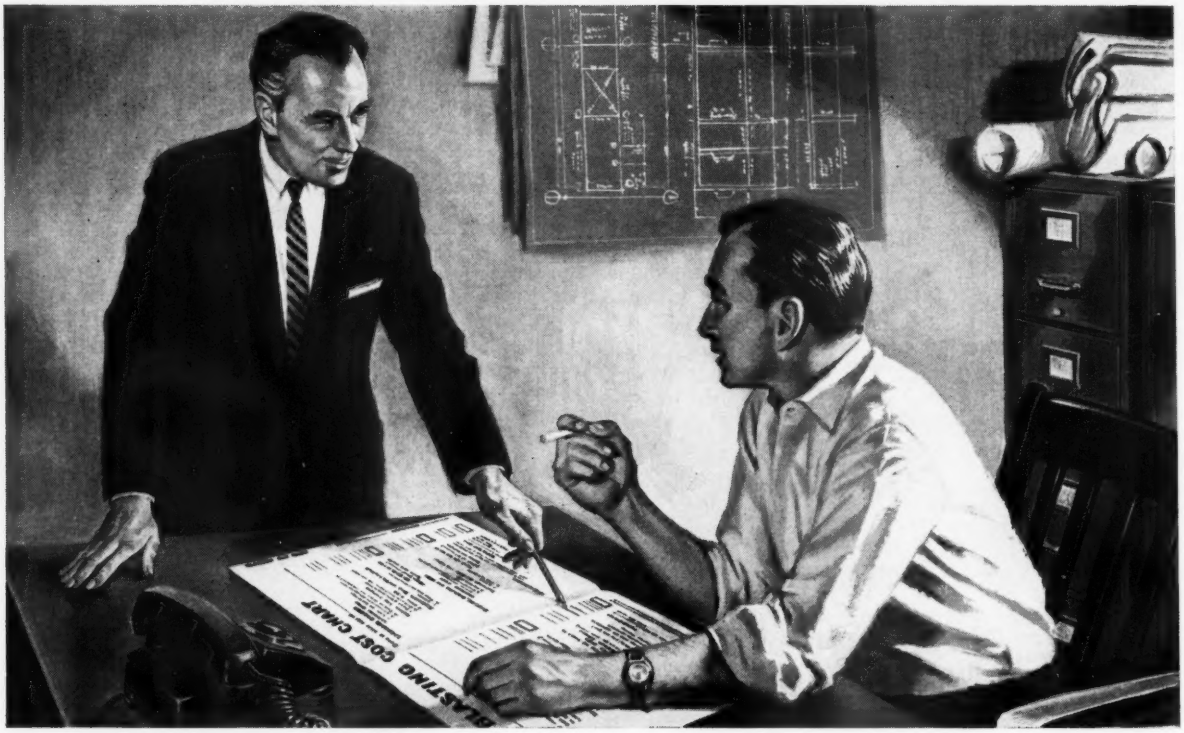
Here's how to count the number of parts supporting the load. Draw an imaginary line across the parts of the rope supporting the load.

The efficiency of reeving systems ranging from one to eight parts is shown in charts which Union Wire Rope engineers make available to users.

Your Tuffy distributor will help you with any wire rope problem

If you aren't acquainted with him, look under "Wire Rope" or "Slings" in the classified pages of your telephone directory. And ask him to put you on the mailing list for free "Rope Dope" educational bulletins. They're packed with boiled-down, useful information on the selection and care of wire rope for greatest service.

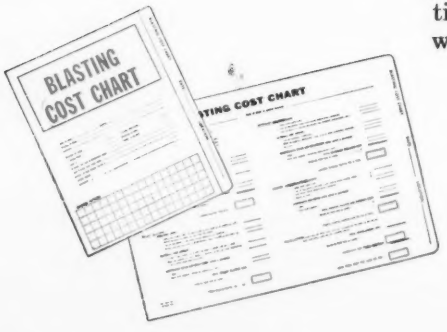
TRUE
WHAT ARE YOUR ^ BLASTING COSTS?



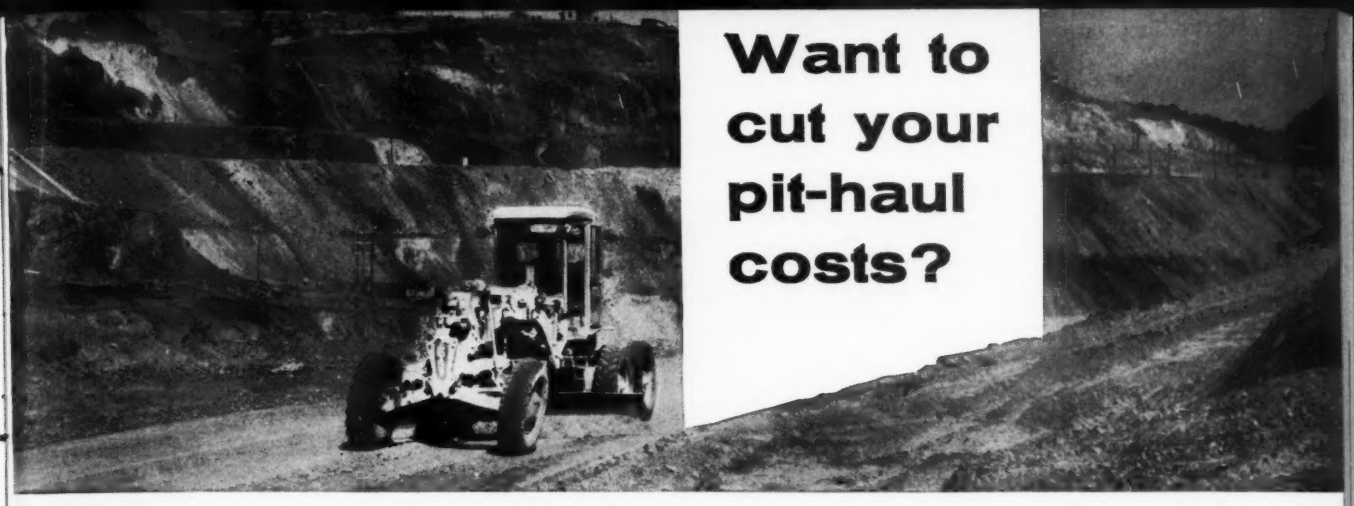
Get a complete profit picture with new, free Blasting Cost Chart! Let the Atlas Man show you how

Explosives costs alone don't always determine value of a blast. The explosives used have a direct effect on drilling, digging, hauling and crushing costs. Now, a free, simplified computing method—developed by Atlas, gives you a true, complete cost analysis of profits, without involved bookkeeping.

The Atlas Blasting Cost Chart enables you to protect or improve your profits. What's more, it's yours without cost and you can keep your figures confidential. The Atlas representative nearest you will be glad to show you how it works—without obligation.



EXPLOSIVES DIVISION
ATLAS POWDER COMPANY
WILMINGTON 99, DELAWARE *offices in principal cities*



Want to cut your pit-haul costs?

How 15-speed "blade" can help your haulers make extra pit-to-plant trips every day

You'll reduce the per-ton cost of hauling, boost pit output every day, by traveling your haulers at higher speed. Faster haul speeds are practical *only* when your pit floor, benches, and haul roads are kept clean, smooth, and well drained. The better your surface, the faster you haul... the more trips per day, the lower your pit-haul costs.

To keep your haul routes in tip-top shape you need graders that can do maximum work. You need machines that can make heavier cuts, push bigger loads, work and travel faster ... machines that can always work your tough materials at, or near, full power. This requires a wider range, and more selective gear-ratios than most graders afford.

More speeds for full-power work

Only Adams* 80 to 150 hp graders give you the extra work-speeds you need. They provide 8 standard speeds forward and 4 reverse, plus 3 creeper gears (opt.)... that's 15 speeds in constant-mesh transmission.

For building and maintaining haul roads, ditching, and clean-up at pit, plant, and stockpile, Adams gives you 4 efficient forward working speeds. Other graders with 6 forward speeds have only 3 working gears... often cannot develop full push-power at the faster speeds that are "just right" for the job.

Adams' 2 intermediate gears, 10 and 14 mph, are handy for light, fast blading, snow plowing, maneuvering and climbing tough grades. And travel speeds to 26 mph save time between grading assignments... time that can be used for extra blade-work.

Up to 30% more push-cycles on one-way grading

Most graders have only 2 reverse gears... about 3 and 7 mph. Adams has 4 reverse speeds — 2 for working, 2 for high-speed back-up. Adams' top reverse speeds (8 and 13 mph) pay big dividends. Often your operator works a 200′ to 400′ stretch, or even more, that is too short or too confined to make turning-around worthwhile. Instead, he backs-up. The Adams makes the reverse trip fast... converts usually wasted travel-time to extra blade-work.

Creeper gears for added "muscle", precise control of grade

Three optional creeper speeds, 31′ to 160′ per min. (full power, 0.41 to 1.82 mph), afford a means to concentrate full engine-power for ripping-up and regrading old roadways, pioneering for exploration and new roads, clearing overburden of stumps and roots and working thru rocky ground. They eliminate the costly common practice of "slipping the clutch" at high rpm to get maximum power at slow speed... reduce shock and clutch wear. Creepers also help you cut more accurate grades, and work in tight places.

190 hp POWER-*Flow** 660

For maximum push-power *at all speeds*, Adams POWER-*Flow* Model 660 with torque converter gives you the effective work-power of an *infinite* number of gear ratios, from 0.0 mph to 27.4 mph forward.

Any one of the 7 Adams graders — 190, 160, 135, 123, 115, 85, and 60 hp — will handle more work per $ investment. There is a size to fit your grading problems in any type of pit-plant situation. In any size, Adams will keep your haul routes smoother than can similar competitive machines. Call us for details.

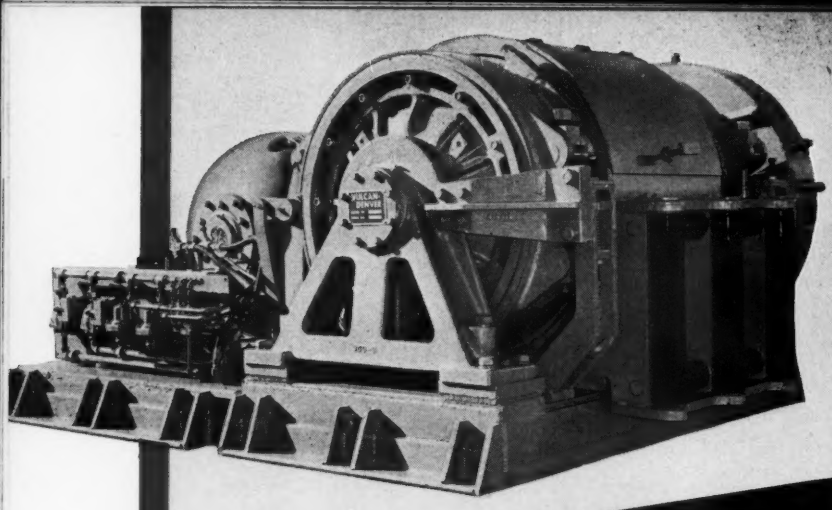
Adams graders can handle more of your type of jobs, save time and money with efficient interchangeable attachments. These include: *Scarifier* for ripping-up old roadways and rock-filled soil, *bulldozer* for spreading and casting dirt and road materials, *snow equipment* for clearing roads, *push-plate* for push-loading scrapers and starting balky haulers.

*Trademark G-1626-MQ-1

LeTOURNEAU-WESTINGHOUSE COMPANY, PEORIA, ILLINOIS

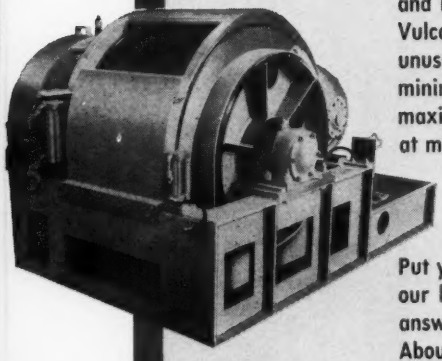
A Subsidiary of Westinghouse Air Brake Company

Where quality is a habit

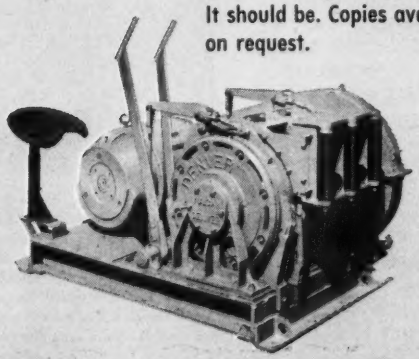


SPECIAL SLUSHERS SOLVE MORE PROBLEMS

Customers who come to Vulcan-Denver for special slushers like these do so knowing there are standard Vulcan units available with comparable drives, capacities and long service life. In each case a Vulcan-Denver special solves some unusual problem of physical layout or mining conditions—always with maximum use of standard parts and at minimum expense and delay.



Put your unusual slusher problems in our hands for a competent, economical answer—no obligation of course. About standard Vulcan-Denver slushers, is our Catalog DB5506 in your files? It should be. Copies available on request.



VULCAN IRON WORKS CO.
2960 SOUTH FOX

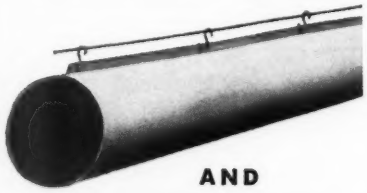
VULCAN DENVER 1891

PUSH IN
FRESH AIR

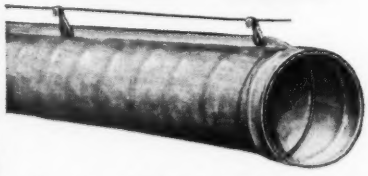
PULL OUT
FOULED AIR

WITH

A B C
NEOLON FLEXIBLE VENTILATION TUBING

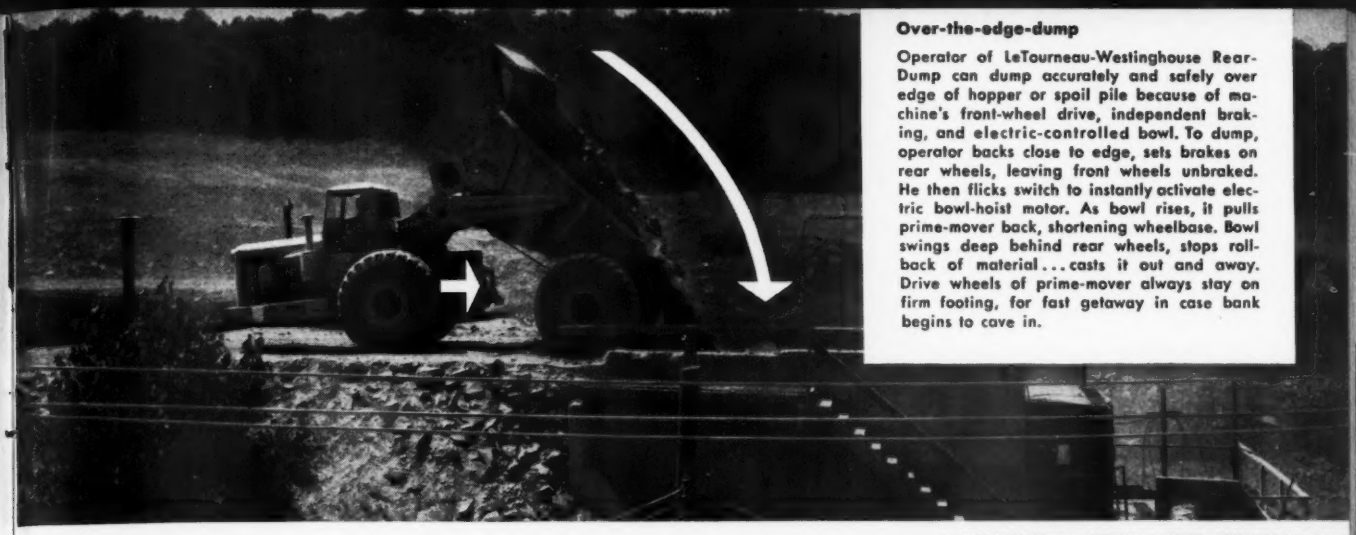


AND
WIRE REINFORCED NEOLON TUBING



"Push In and Pull Out" ventilation is becoming increasingly popular in mines because of its effectiveness. A B C Tubing of **NEOLON**—the amazing, tough, rip-proof neoprene coated nylon fabric—gives longer service with maximum economy. Regular **NEOLON** Flexible Tubing for blowing in fresh air and Wire Reinforced **NEOLON** Tubing for exhausting fouled air. All standard diameters, in any length. Both types easy to couple and choice of "S" hook or Rivet Hook suspension. A B C Tubing is the most complete line. Send for Catalog 158.

AMERICAN BRATTICE CLOTH CORP.
310 S. Buffalo St., Warsaw, Indiana



Over-the-edge-dump

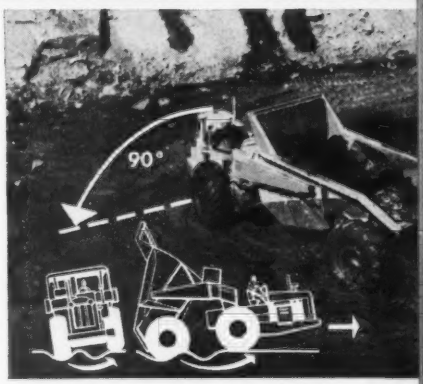
Operator of LeTourneau-Westinghouse Rear-Dump can dump accurately and safely over edge of hopper or spoil pile because of machine's front-wheel drive, independent braking, and electric-controlled bowl. To dump, operator backs close to edge, sets brakes on rear wheels, leaving front wheels unbraked. He then flicks switch to instantly activate electric bowl-hoist motor. As bowl rises, it pulls prime-mover back, shortening wheelbase. Bowl swings deep behind rear wheels, stops roll-back of material . . . casts it out and away. Drive wheels of prime-mover always stay on firm footing, for fast getaway in case bank begins to cave in.

COMPARE

- **capabilities of your present haulers**
- **advantages of L-W Rear-Dumps**

Hauls through soft, slippery areas

L-W Rear-Dumps haul safely through areas where other units bog down. Here's why: (1) Exclusive power-transfer differential, automatically transfers power from a slipping drive wheel to wheel on better footing. (2) 90° kingpin electric steer . . . independent of drive train . . . helps you "duck walk" out of trouble. Operator just turns prime-mover left, right, left, etc., to swing drive wheels ahead until they "walk" out and reach solid footing. (3) Rear-Dump can be "humped" forward, when bowl is empty, to get out of soft areas. Bowl is raised with front brakes locked and rear brakes released, shortening wheelbase . . . then bowl is lowered with rear brakes held and front released. Thus, without use of drive wheels, Rear-Dump "humps" forward.

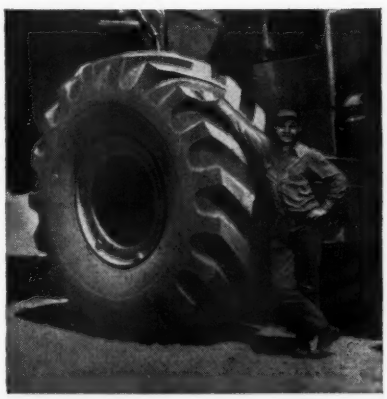


No-drag "skid bottom" construction

There are no springs, hangers, tie-rods cluttering up the bottom of your L-W Rear-Dump. Simple "skid bottom" construction eliminates drag over dirt and rocks. Bowl is hitched to prime-mover through a horizontal yoke extending back from kingpin, and pivoted to body itself . . . just above and ahead of rear wheels. There is no frame or sub-frame to get out of alignment. Front-wheel drive and kingpin steer eliminate long drive shaft, hinged steering connections.

Big target for fast, easy loading

L-W Rear-Dumps' big, wide, unobstructed top makes an easy target for your shovel operators. Low, wide rear entry of this hauler lets dipper swing in smoothly, quickly . . . in one continuous arc . . . rather than the up-over-in, up-over-out motions needed with high-top trucks.



Big, single tires absorb shock, eliminate trouble of duals

4 giant, low-pressure tires dissipate vibrations and stress of high-speed hauls . . . absorb shock of heavy loads dropped into bowl. They flex and roll easily over rocks that might bruise or break smaller duals. There is no divided face where wedged-in rock fragments can wear and tear.

Write or phone your local L-W Distributor for more information on these big-production, low-cost Rear-Dumps. They are available in 11, 22, and 35-ton sizes.

R-1871-MQ-1

LETOURNEAU-WESTINGHOUSE COMPANY, PEORIA, ILLINOIS

A Subsidiary of Westinghouse Air Brake Company

Where quality is a habit

More Wheat Lamps in More Modern Mines

...month after month, every year!

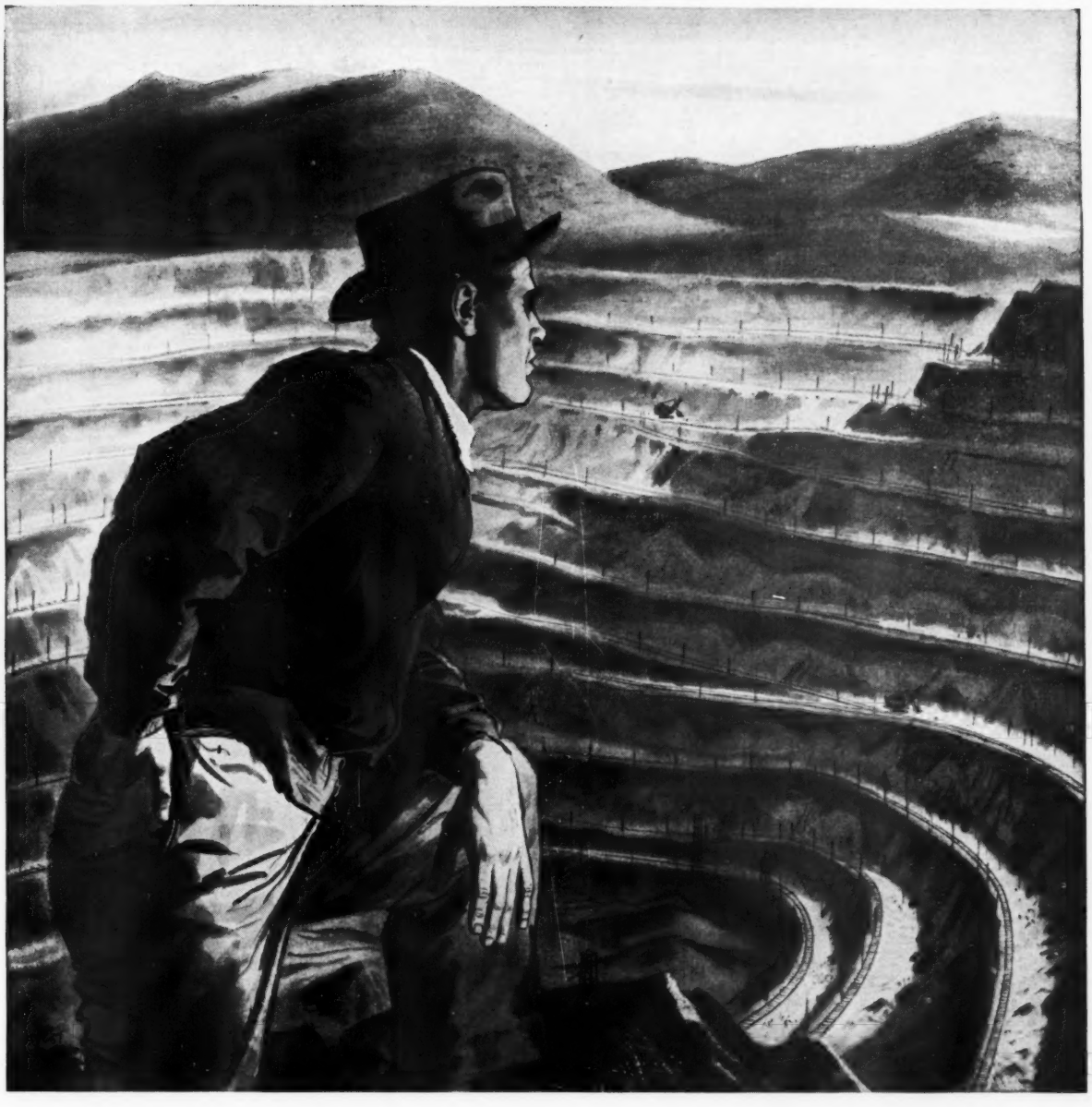
Self-evident value sells WHEAT. Wheat sales forge regularly ahead because Wheat plainly provides *more light* per contract dollar. Wheat sales advance in the largest operations and in the smaller progressive mines—size presents no barrier to the Wheat combination of high-standard lighting and exceptionally low-cost maintenance. Charging is automatic—for one or any number of lamps. *Let us detail the facts.*

National Mine Service Company

Koppers Building, Pittsburgh 19, Pennsylvania

All-State Division, Logan, W. Va. | Anthracite Division, Forty Fort, Pa. | Ashland Division, Ashland, Ky. | Bemeco Division, Beckley, W. Va. | Clarkson Division, Nashville, Ill. | Greensburg Division, Greensburg, Pa. | Kentucky-Virginia Division, Jenkins, Ky.

Mountaineer Division, Morgantown, W. Va. | Western Kentucky Division, Madisonville, Kentucky | Whiteman Division, Indiana, Pa.



the profit you left behind

There it lays in the dirt. Your machines and equipment ground off in the grit, pounded off in the rock and ore. You can almost see the wear that shut down your machines too soon . . . idled your men too long . . . bled your profits too much.

Is there *one* material, *one* metal that can stop this excess wear waste?

One? It takes many alloys, engineered alloys (some you may never have heard of). It takes a list of Amsco® Alloys to span the entire range of wear applications.

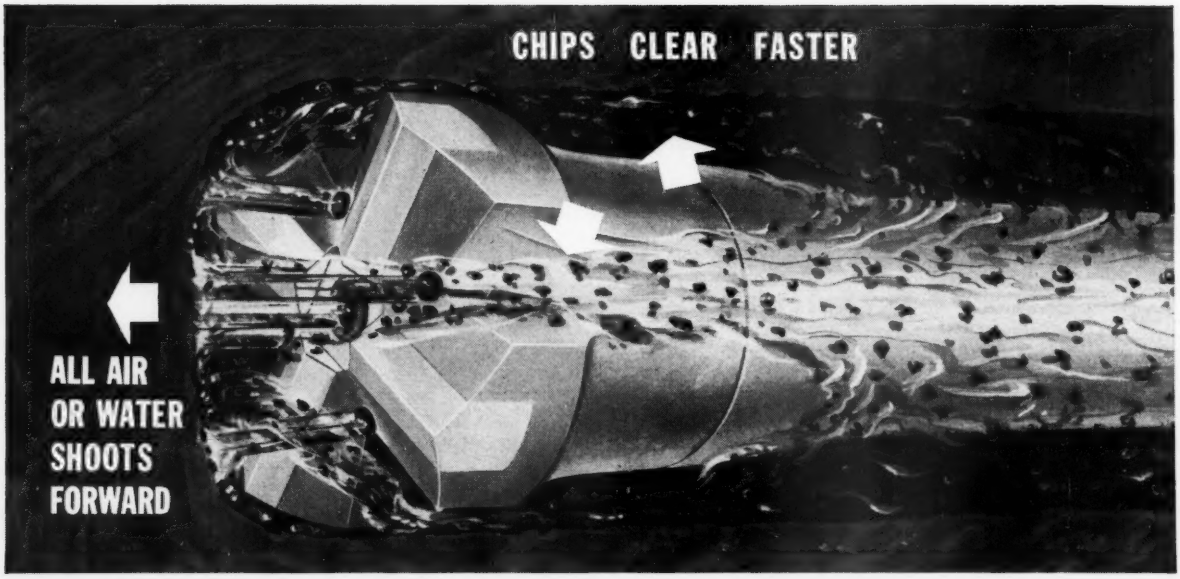
Amsco Alloys that can work a full shift where severe abrasion knocked out toughest metals in three hours. Amsco Alloys that can belt rock and ore all day, and work tomorrow, too. Amsco Alloys that can work any abrasion-impact combinations you face and still resist the wear, stop the waste . . . save the profit!

When you need the *best* alloy for the job, you'll find it *first* among the Amsco Alloys . . . engineered by America's largest producer of cast manganese steel and specialists in wear-resistant metals.

AMERICAN Brake Shoe COMPANY

AMSCO

American Manganese Steel Division · Chicago Heights, Illinois



How new TIMKEN® threaded bit cuts drilling costs on drifters, sinkers and stopers

SPEED DRILLING and cut bit costs with these new Timken threaded bit features. 1) New five front holes and 2) wider wing clearance speed chip removal; and 3) new wear-resistant carbides give longer bit life.

The action picture above shows how you can cut drilling costs on drifters, sinkers and stopers. The new Timken® threaded carbide bit drills more hole-per-bit because two new features clear chips faster. 1) Newly-positioned five front holes shoot air or water *directly* against the rock face; and 2) deeper, wider wing clearance lets chips wash back faster. Deeper relief under the heel provides an even freer passage. As a result, the bit spends less time "drilling" chips, more time drilling rock. And removing chips this faster, more economical way eliminates the problem of clogged drill steels, prevents damage to bit skirts.

What's more, the new Timken threaded bit has new special analysis carbides that give increased resistance to wear and shock. They can be reconditioned many times. And improved thread contact reduces breakage to a minimum.

To get more hole-per-bit, use the new Timken threaded carbide bit. For more cost-saving details, send for free brochure. The Timken Roller Bearing Company, Rock Bit Div., Canton 6, Ohio. Cable: "TIMROSCO".

USE THESE TIMKEN BITS FOR OTHER TOUGH DRILLING JOBS

IMPROVED TIMKEN ALL-STEEL MULTI-USE BIT

With correct, controlled reconditioning, gives lowest cost per foot-of-hole when full increments of steel are used.

THE AIR-LEG BIT OF THE FUTURE

New Timken tapered socket bit is removable for full steel life yet tapered for one-piece strength. Same frontal features as threaded bit.

TIMKEN TRADE-MARK REG. U. S. PAT. OFF.

REMOVABLE ROCK BITS

AT HOME ON THE "RANGE"

If there's an 8-yard mining shovel in your future, make it a Marion 181-M.

Here's a husky machine with the traditional strength, power and endurance of Marion mining shovels—plus small machine cycle time for an extra payoff every day.

The 181-M has a combination of design, construction and performance features that can lower your costs and add to your profits.

If you haven't seen Bulletin 439 on this 8-yard Marion, write for your copy today.

You get **MORE** *with* **MARION**

MARION POWER SHOVEL COMPANY • Marion, Ohio

A Division of Universal Marion Corporation

US RUBBER **CONVEYOR BELTS**

In Jamaica, B.W.I., moving a million and a half tons of bauxite a year from back up in the hills to port loading facilities is a tough, complicated job. Climate, rough terrain, abrasion, great distances—all have to be overcome. Reynolds Metals Co. moves its bauxite production underground and overland on dozens of "U.S." Belts... first as cold, sticky, abrasive run-of-mine ore, later as crushed fines right from red-hot drying kilns.

"U.S." belting engineers, working closely with engineers of the conveyor system and of Reynolds, selected and designed the belts to handle the many different problems of movement and material. It's this specialized belting "know-how", plus the finest product available, that assures you of the right belt for the job every time.

When you think of rubber, think of your "U. S." Distributor. He's your best on-the-spot source of technical aid, quick delivery and quality industrial rubber products.

Visit Our Booth #505 AMC, San Francisco, September 22-25

US RUBBER **Mechanical Goods Division**

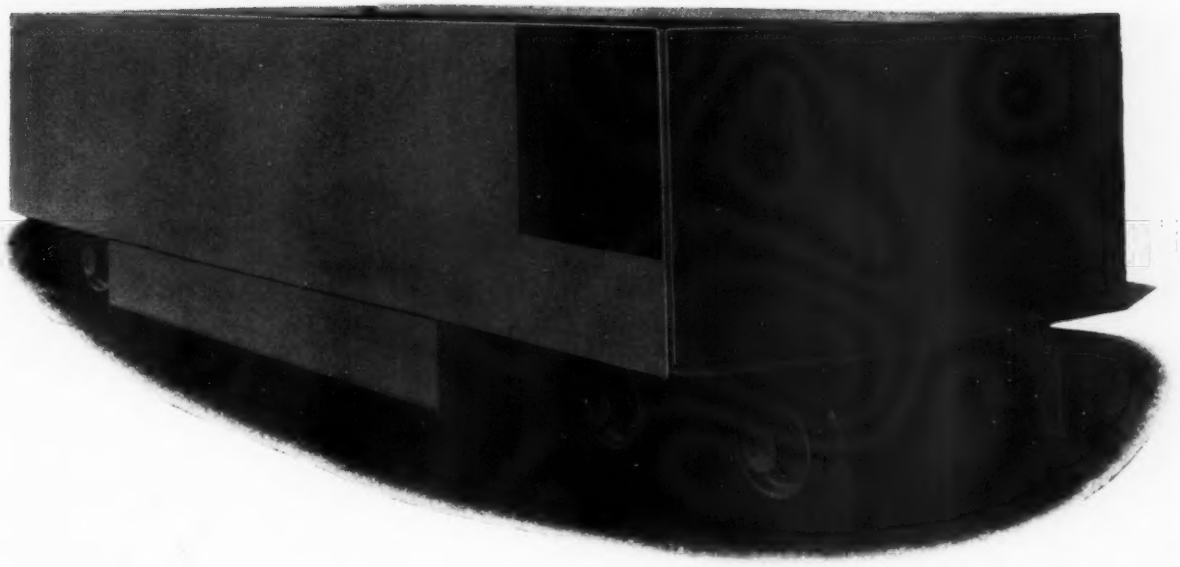
United States Rubber

WORLD'S LARGEST MANUFACTURER OF INDUSTRIAL RUBBER PRODUCTS

Rockefeller Center, New York 20, N.Y. In Canada: Dominion Rubber Company, Ltd.

LOW

but we didn't skimp on capacity



Bethlehem built this car for a customer with a problem. He needed a low car, and he didn't want it excessively long. Yet, at the same time, there had to be plenty of capacity. Bethlehem engineers worked up a design that filled the bill completely.

The finished car stands only 4 ft above the rails. Its inside length is 16 ft 6 in. Capacity (level), 390 cu ft; with 6-in. surcharge, 446 cu ft. Nominal load capacity, 11 tons.

Equipment includes automatic couplers, spring draft gear, forged-steel wheels, and fabricated trucks with roller bearings. Body parts in contact with the lading are corrosion-resistant steel.

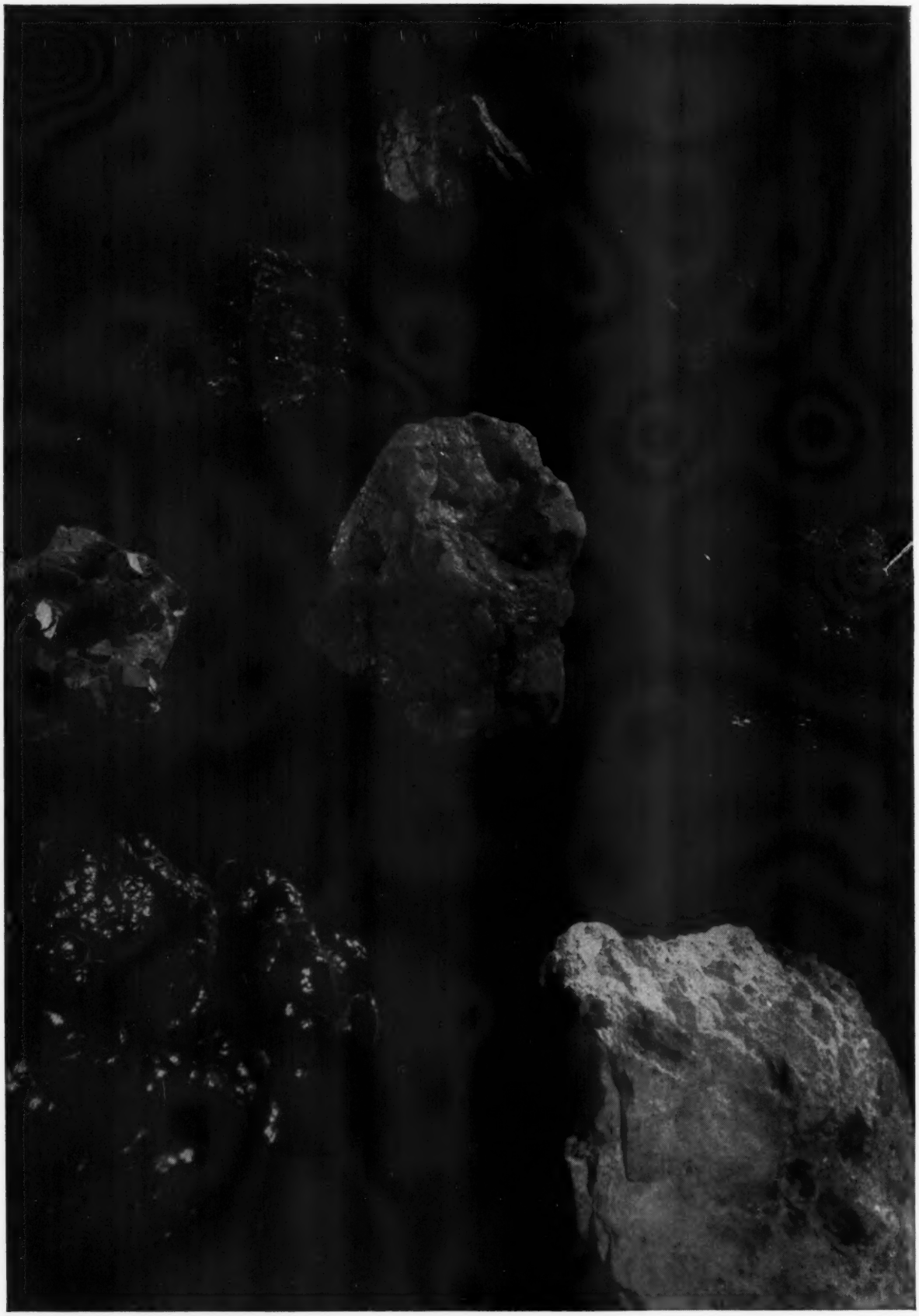
When you decide to expand your own fleets of cars, let Bethlehem quote you. We are set up to construct any welded or riveted model for end-dump or rotary-dump service. Details of design and engineering can always be worked out to meet your requirements.

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation. *Export Distributor:* Bethlehem Steel Export Corporation

BETHLEHEM STEEL

BETHLEHEM STEEL



These represent a few of the minerals with which Separan 2610 is improving flocculation and lowering processing costs: CHROMITE, URANINITE, GALENA, SPHALARITE, CHALCOCITE, ALUMITE, COAL, HEMATITE.

For a wide variety of minerals Separan 2610 provides record-speed flocculation

NEW FLOCCULANT PROVES ITSELF IN NUMEROUS OPERATIONS

It's a fact—proven in many types of operations, with a wide variety of materials: Separan® 2610 has doubled, and often tripled, production rates!

Equally remarkable: only a few hundredths of a pound are needed per ton of solids!

New economies are being realized in processing uranium, lead, zinc, coal, copper, alum, and a host of other sulfide and non-sulfide minerals. Operations involving concentration, leaching, thickening, and refining are benefiting with Separan 2610, especially since this revolutionary flocculant is so easy to prepare and apply. A mechanical mixer is not required. You can prepare large amounts of stock solution with a new dispenser recently made available. And Separan 2610 is effective in both acid and alkaline circuits. In addition, it adds no excess bulk.

Try Separan 2610 yourself!

A sample and technical assistance are yours upon request. THE DOW CHEMICAL COMPANY, Organic Chemicals Sales, Midland, Michigan, Dept. OC 1060A.

When your process calls for chemicals, talk to the man from Dow

XANTHATES • DOWFROTH® 250 • Z®-200
SEPARAN 2610 • HYDROCHLORIC ACID
AMMONIA • CHLORINE • CAUSTIC SODA
VERSENE® • MAGNESIUM OXIDE
MAGNESIUM HYDROXIDE • ION EXCHANGE
RESINS AND SOLVENT EXTRACTANTS.

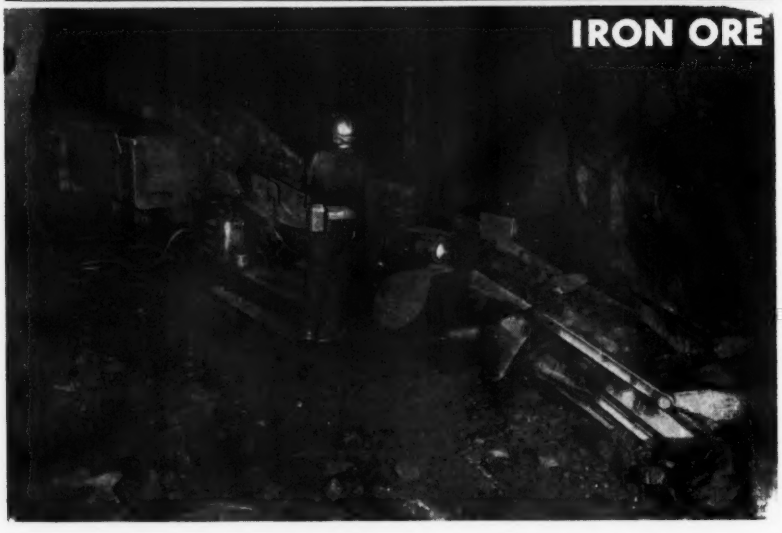
HERE ARE EXAMPLES of how little Separan 2610 is required: In thickening copper tailings, clearer overheads and better filtration are reported with only 0.0041 pounds per ton of solids. Similar improvements are taking place in uranium filtration at 0.5 pounds per ton.

YOU CAN DEPEND ON DOW

The Whaley "Automat" has no equal in cost saving on either a per dollar of equipment investment, or per ton of material loaded, or per foot of advance!

WHALEY "AUTOMAT"

BACKED BY 50 YEARS OF MECHANICAL LOADER BUILDING EXPERIENCE!



Some Uses in Rock Loading

1. Taking Top or Bottom—Coal Mines.
2. Cleaning up Roof Falls.
3. Driving through Rock Faults.
4. Grading Haulage Ways.
5. Driving Tunnels or Headings.
6. Loading Rock Partings—Coal and Rock.
7. Loading "Muck" in Tunnel Driving.
8. Loading Ore and Rock in Metal Mining.

• • •

For years the "Automat" has been used in many efficient operations in Rock, Coal and Ore loading. Its effectiveness, ruggedness and maneuverability make it an essential unit in modern mining!

Write us for complete information on machines for your work. Myers-Whaley Co., Knoxville, Tenn.

MYERS-WHALEY

"OLDEST BUILDERS OF UNDERGROUND LOADING MACHINES" • Knoxville, Tenn., USA

Allis-Chalmers saves you money

DO MORE POWER

3 ways

Provides maximum work per operating dollar—Allis-Chalmers engines give you real *Do-More Power* — with high torque, efficient combustion that squeezes the last bit of energy from every bit of fuel.

Keeps working day after day—There is unusual performance in rugged Allis-Chalmers engines — there is less wear, less that can go wrong.

Gets back to work faster — Design simplicity means easier servicing, too. Allis-Chalmers diesel engines are back to work quickly because you are close to fast parts and service, wherever you are.

See your Allis-Chalmers dealer for full information on engines that save you money, 9 to 516 hp, any fuel, any application. Allis-Chalmers, Milwaukee 1, Wisconsin.

ALLIS-CHALMERS

See us at the American Mining Congress
San Francisco
September 22-25
Booths
130-140-240

Koehring Model 205 ½-yd shovel with Allis-Chalmers 273 engine loading copper ore at Tejano Mining Company in New Mexico. BC-17A

New **Longer-Wearing** Pattern in Wire Rope Styles!

After three years of extensive field trials this, the newest of Roebling's wire ropes, is now ready to go to work for you on a service basis that will exceed that of *the wire rope you are now using.*

Roebling Herringbone* combines the best features of both regular and Lang lay rope constructions; being made up of two *pairs* of Lang lay strands and two strands of regular lay. The regular lay strands separate the two pairs of Lang lay strands. Thus, in one rope you have the superior flexibility and abrasion resistance of Lang lay and the greater structural stability of regular lay.

For the past three years, under all kinds of conditions, Herringbone has been used for general hoisting, holding and closing lines, shovel ropes, wagon scraper ropes and dragline ropes. The results have been wonderful . . . excellent flexibility, exceptional resistance to shock and abrasion, smooth, easy operation around drums and over sheaves, smooth spooling properties and structural stability unequalled by other rope for the same job.

There has never been a better time—or a wider need—for a wire rope that returns so much service for its cost. And, in addition to being a top performer on the job, Herringbone eliminates the necessity of stocking Lang lay for one purpose and regular lay for another.

You are invited to get in touch with your Roebling distributor or write Wire Rope Division, John A. Roebling's Sons Corporation, Trenton 2, New Jersey, for further and fuller details on the *investment* qualities of this new and highly serviceable rope.

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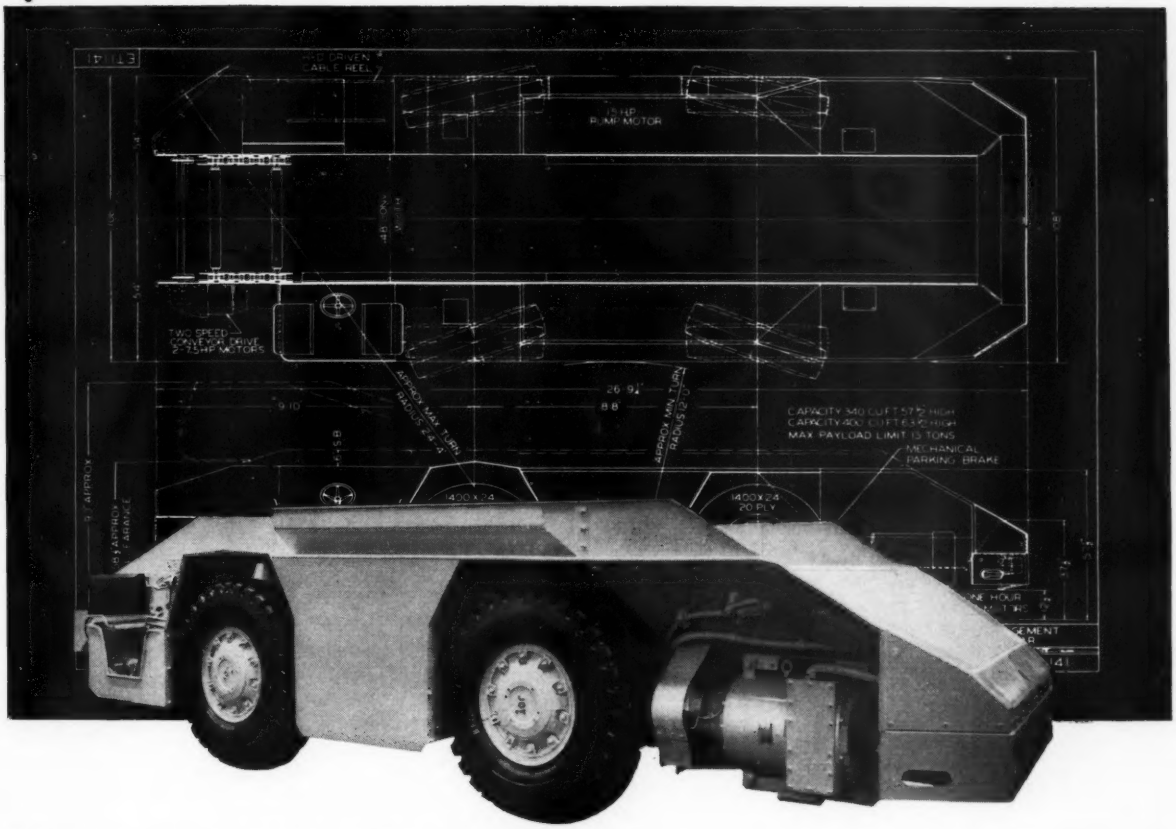
New! HAUL 15 TONS IN ONE LOAD WITH JOY HIGH SEAM SHUTTLE CAR



At last—a shuttle car designed specifically for *really* high seams . . . the Joy 15SC. This new shuttle car is 57″ high . . . hauls 15 tons in one load. The result is easier, faster loading; fewer trips; cheaper haulage.

The 15 SC is powerful. Two 2-speed 25 HP traction motors, two 2-speed 7.5 HP conveyor motors and one 15 HP pump motor provide plenty of power for fast haulage regardless of conditions.

Maintenance is easier, too. Extra-rugged wheel-drive units, twin-boosted power steering, ventilated disc brakes, and special frame construction add up to money saving operation. And the Joy system of using five motors eliminates clutches, torque converters, complex gearing and transmissions.

The chart at right shows average tramming speeds that really roll up tonnage. If your operation will accommodate a 57″ car, talk to your Joy engineer about the 15 SC . . . he's got 20 years of shuttle car experience behind him. ***Joy Manufacturing Company, Oliver Building, Pittsburgh 22, Pa.*** In Canada: *Joy Manufacturing Company, (Canada) Limited, Galt, Ontario.*

APPROXIMATE TRAMMING SPEED

Loaded level	4.45 mph
Empty level	5.9 mph
Loaded 8% grade	2.89 mph
Empty 8% grade	3.7 mph
Loaded 15% grade	2.35 mph
Empty 15% grade	3.0 mph

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CONTINUOUS MINERS, MOBILE LOADERS, SHUTTLE CARS, COAL CUTTERS, CUTTING MACHINE TRUCKS, COAL DRILLS, CONVEYORS, TIMBER SETTERS, SHUTTLE CAR ELEVATORS, BELT FEEDERS, FANS, BITS, PORTABLE BLOWERS, COMPRESSORS, ROCK DRILLS, HOISTS, CORE DRILLS

EDITORIALS

ROBERT W. VAN EVERA, Editor

SEPTEMBER, 1958

A SENSIBLE SOLUTION

The necessity for joint action in the tax field was strikingly illustrated by a provision in the Technical Amendments Act recently signed by the President. Section 37 of that measure, commonly referred to as the Mills bill, removes an unintended hardship on the mining industry—a hardship which grew out of the Internal Revenue Code of 1954.

Section 614 of the 1954 code defined, for the first time, the term "property" for the purpose of computing the depletion allowance. Among the principal defects of that provision were (1) where two or more mines were contained within a single operating unit, each mine consisting of multiple acquisitions, the owner could not treat each mine as a depletion unit; and (2) where a large tract contained several mines, the mine owner was required to treat the entire tract as a single property.

Section 37 of the Mills bill places in the law a workable, flexible and realistic definition of the "property." In general, a taxpayer will be permitted to treat each deposit in each acquisition as a property, or to treat any mine as a property, or to treat any combination of mines within an operating unit as a property. Further, the taxpayer will be permitted to split up a large tract so that each mine —or any combination of mines within an operating unit—on that tract may be treated as a separate property. In addition, the time of election as to how a particular acquisition shall be treated is postponed to the development stage rather than the exploration stage.

This new provision in the law is complicated and technical, and will require extended study by tax men. Because of its complexity, a provision of this type could not be obtained without bringing together highly competent representatives of all branches of the mining industry. Also it was vital to have a cooperative attitude on the part of Government personnel desirous of arriving at a proper solution. The chairman and members of the Tax Committee of the American Mining Congress can justly be proud of their part in this effort, and pleased that the end result is a beneficial, sensible solution to a difficult problem.

WE'RE COMING THROUGH— LOUD AND CLEAR

The Federal Communications Commission recently issued an order which will make more radio frequencies available for communications used by mining and other industries. In creating a new Special Industrial Radio Service, with a fairly large number of frequencies open to mining use, the Commission cast aside a proposal which would have lumped major industries and a host of other types of radio users into a "Business Radio Service." Had the FCC stamped its approval on this proposal, mining would have been relegated to inferior and crowded radio accommodations.

The FCC is to be commended for its careful consideration of pleas by the American Mining Congress, the American Iron Ore Association and others to make additional frequencies available, and particularly for recognizing the need for a voluntary frequency advisory system under which radio users will be able to make maximum use of the frequencies with minimum interference.

Representatives of agriculture, mining, construction, petroleum services, and others have recently participated in a series of meetings to consider the allocation of radio frequencies within the Special Industrial Radio Service. A national frequency advisory service and a series of regional and area advisory committees will be established as a result of these conferences. These agencies will recommend radio frequencies to eligible users which will enable them to maintain effective communications systems at their plants or mines. The industries falling within the Special Industrial Radio Service have indicated that they will support this new service wholeheartedly.

Mining companies using radio as a part of their communications system are urged to get behind the frequency coordination effort. By doing so, they will obtain the best possible frequencies for their use and alleviate the present interference that is hampering mining and allied operations in many areas.

Use of radio communications in mining has proven to be a real cost-cutting tool. Many mining companies have applied it successfully in recent years, particularly in open-pits, strip mines and quarries. Yet, as compared with radio use by other industries, its application in mines is still in its infancy. The mining industry has been slower—probably for good reasons—to apply this new tool than the manufacturing industries, but the potential for more efficient production through use of radio communications is enormous. Increasing numbers of progressive managers and engineers are looking into possible radio applications at their operations.

Although FCC action in making additional frequencies available to industry is helpful, it does not assure that ample allocations will always be available in the future. Radio use is mushrooming in so many industries that the additional frequencies made available may be taken up in a few years. It is advisable, therefore, that mining industry leaders look into their future radio requirements promptly in order to acquire suitable allocations before other industries, which are aggressively competing for these new frequencies, have grabbed them all.

The employee who feels that management has a personal interest in his safety is more likely to be a better worker—and a safer worker

Management's Viewpoint on Safety

It is management's duty to inspire employees to greater safety in all activities

By WALTER A. STERLING
President
The Cleveland-Cliffs Iron Co.

WHEN one realizes that in 1956 accidents cost this nation $11,200,000,000, these shocking figures indicate that with a problem of this magnitude, management must do more than merely have a "*viewpoint*" regarding safety! Management must motivate safety! Management doesn't dare to follow the passive philosophy of President Coolidge's clergyman, who was "agin" sin. It can't simply authorize a defense against accidents, it must lead a vigorous, never-ceasing fight for safety.

Industrial Safety Less Than 100 Years Old

The principles of "safety on the job" are less than one hundred years old. In 1867 Massachusetts, first state to become safety-minded, began the use of factory inspectors. Ten years later the state enacted a law requiring the covering of dangerous machinery. In 1898 a law was passed making the employer liable for accidents. In 1911 The Cleveland-Cliffs Iron Co. established a Safety Department. In that year the first effective Workmen's Compensation Act was passed in Wisconsin. It was also in 1911 that a request came from associations of electrical engineers in the iron and steel industry, calling for a general industrial safety conference, on a national level. The result was the first cooperative Safety Congress, which met in 1912 in the City of Milwaukee. This gathering called for another meeting in New York the following year (1913). At that meeting the National Council for Industrial Safety was organized. Shortly after, the name was changed to the National Safety Council and its program broadened to include all types of accidents. Although the National Safety Council was created under no compulsion by industry, today it is chartered by the United States Government, the same as the American Red Cross.

We must admit that the mining industry is a hazardous one. Steel is also in this category, but maintains a low accident rate. So, it follows that with a carefully planned program of safety, where every employee of mining companies thinks, breathes and lives safety, mining will be a safe industry. Naturally, the voice of management will be heard in this connection.

Supervisory Level Provides Immediate Contact

The two levels of management have separate responsibilities relative to safety. The supervisory level is indispensable to effective safety work, furnishing the immediate contact and exercising immediate control over employees departmentally. The supervisor can control accidents in his department by minimizing the degree of hazard and by eliminating unsafe acts, by attitude and by example. He must convince his men he is FOR safety. The successful supervisor has found that the production job is done easier and better when accidents are prevented; that it takes less time, and costs less money, to prevent accidents than it does to have them.

As the key figure in the program, the supervisor has certain specific responsibilities. He administers the safety rules. The supervisor must have a working knowledge of all safety principles and a specific knowledge of the safety rules applicable to his department. He must be able to instruct his employees in these rules in order to perform their jobs with greater efficiency and protection to themselves. He trains both the new employees and the transfers from other departments. Unfamiliar with his environment, the new worker requires special and continuing attention. He is in need of instruction in performing his duties so as to avoid unsafe acts. The supervisor sees that the right equipment and tools are selected for the job and kept in good repair and used correctly. The supervisor makes sure that employees are provided with proper protective equipment and that it is properly used. The supervisor promotes good house-

keeping, an essential ingredient of safety performance. The supervisor develops efficient material handling procedure such as proper lifting, safe and adequate transportation and other facilities. The supervisor checks fire protective equipment, for proper maintenance, and makes sure that employees in the area are trained in its operation. The supervisor investigates all accidents, regardless whether injury resulted, to determine the cause and to prevent recurrence.

A quality essential to a successful safety program and to successful supervision is good human relations. This explains why, as a general rule, the supervisor with a good production record is equally successful in maintaining a good safety record. The supervisor who has the respect of his employees may be assured of their cooperation. Once an employee fully understands the supervisor's motives in maintaining a safe operation, he will not only cooperate wholeheartedly but also will enjoy the satisfaction that comes with the feeling of belonging to the organization. This feeling will be fostered if suggestions for improvement of safety performance are encouraged and accepted by the company.

Top Management Responsible for Entire Safety Program

Now we come to the part top management must play in industrial safety. What is the relationship of top management to safety? There is, first of all, responsibility. Management, as the employer, must be certain that the employment furnished is safe—with safety devices, safeguards, methods and processes which protect health and safety of all employees. Similar to other phases of business operation, the company safety program must also have leadership and guidance. Although management assigns administrative responsibility to one individual, the Safety Director, nevertheless top management ever must look over the shoulder of the Safety Director; as top management constantly observes its financial officer to assure commitments in finance, so must safety be assured in operations.

More than forty years ago, when industry began to get ideas about safety and safe practices, the program did not provide for plant-wide inspection and the replacement of all machinery or apparatus that carried a hazard. Safety moved into industry slowly. Generally, management's contact with safety was sitting in the office and reading an accident report. Investigation following a minor accident resulted in the erection of a railing or a guard over the dangerous machine. The safety drive was directed at machinery, but there were still many mechanical accidents. It took some time before the heads of

Walter A. Sterling is a distinguished member of the minerals industry and is highly qualified to write on management's viewpoint on safety. A graduate of the University of Michigan, Sterling joined The Cleveland-Cliffs Iron Co. as a mining engineer in 1919. Three years later he left to join E. W. Coons Co. as a construction superintendent. In 1929 he returned to Cleveland-Cliffs as superintendent of the Canisto mine at Coleraine, Minn. Sterling became general superintendent of the company's properties on the Mesabi Range in 1940 and was made manager of the Minnesota mines in 1947. In 1950 he was appointed vice-president in charge of mining operations, and in 1953 became president of the company. A few months ago Mr. Sterling's duties were increased to include those of chairman of the board.

industry learned that all accidents are not caused by mechanical failure but that many of them can be caused by human failure. It was found that the attitude of the listless worker had direct relation to accidents. The weak link still existed in the mechanical plant because the workmen in the plant were not robots but human beings. When recognition was given to the individual, comparison studies show that accident rates decreased.

Showing a Personal Interest Especially Effective

It is a trait of human character—failing or otherwise—to like being fussed over.

Many members of the human race are emotional. It is estimated that one out of three persons suffers from some emotional maladjustment. People in this category would rather feel an emotional satisfaction than they would being logical. It is that simple. Personal security is one of the fears of the emotional human being. The thought that an employer does something or takes some special interest in the employee or his work, is satisfying to many employees and, in many instances, directs their emotional drive in a more logical direction. The employee who feels that top management is particularly interested in the individual employee's safety is more apt to avoid hazards and follow safety practices and other company regulations.

The general manager of a large eastern department store followed a practice of walking through the entire store every afternoon late in the day. Wherever possible—he didn't miss many cases—he stopped for a brief greeting to every member of the sales force, and the store employed many hundreds. He talked about the weather, if the Giants would win the pennant, the Russian Sputnik, or any subject *not* related to business. This man was a good businessman and he selected the time of day for his visits when store sales were at their lowest ebb and the nerves of the employees were at a state of ragged irritability. It was an hour of inertia. His visits were a greater stimulation than a coffee break. After he passed, heads were raised, bowed shoulders straightened, and extra effort was put forth in the last hour of the work day. His sales report showed that before he began these visits sales were slightly above nil for this last hour of the work day. But after he began his visits, the daily sales chart showed the last hour's curve going upward. This man never mentioned sales. He made no attempt to nag the sales people to work harder or sell harder. But his diplomatic, friendly visits had the effect of increasing sales. People perked up because the "old man" cared enough to be friendly. HE WAS SHOWING A PERSONAL INTEREST. And this is the vital contribution that top management can make to the company safety program.

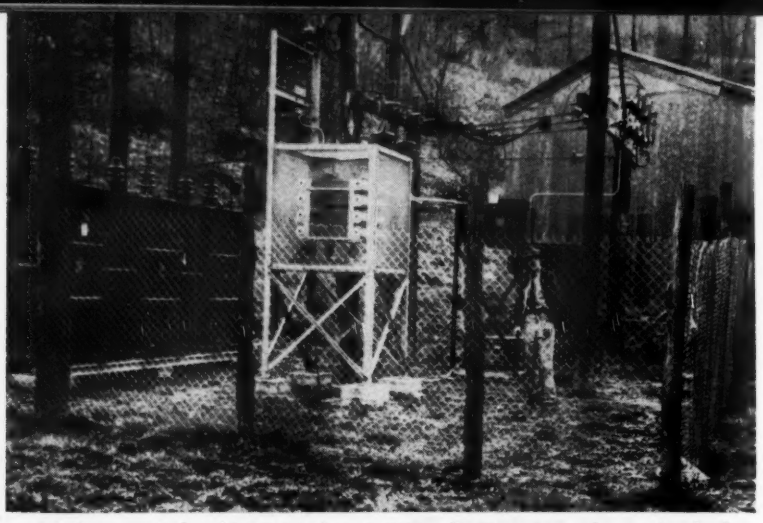
Interest Can Be Reflected in Safety Awards

The industrial relations of a company fill an important sphere, but it is not nearly as important a niche as that which the director of human relations might fill. And this important job should be the function of top management.

Every day it is becoming more and more apparent that dealing in humanities, reaching to the employees individually, is effective. Employees' behavior is influenced by this. Problems have been solved and costs reduced by the careful pursuit of a prepared communication program. The author is not so naive that he believes such a technique is the solution to all employer-employee problems. However, it is of proven value and it is most effective when top management takes a direct and active participation.

For nearly ten years, Cleveland-Cliffs has made a practice to annually give company stock to its employees who have worked forty years without an accident. This stock presentation always follows an annual dinner at which these men are honored guests, and the fete is climaxed by one of the officers giving each a stock certificate. The company has found this program has great value. This value arises not from the monetary value of the security, but that the company heads have a warm feeling for the employees to individually present them with company security. Even if the stock does not have great value, its presentation means a lot to the individual and leads him to feel that he is a part of the company itself. It gives him a sense of being needed and wanted.

Therefore, in closing, let me say that it is the duty of management, from the supervisor to the president, to keep burning forever the light that inspires safety in all our activities.



A primary neutral resistor in service at 4160 volts Y serving a large mine load
(Courtesy of C. S. Conrad, Maintenance Superintendent, Mountaineer Coal Co.)

By C. R. HUFFMAN
Staff Electrical Consultant
Donegan Coal & Coke Co.

FACTORS IN EVALUATING AND SELECTING A-C POWER SYSTEMS FOR UNDERGROUND COAL MINING

What are the major considerations in choosing an a-c power system for underground application? Two electrical engineers combine their experience to answer this important problem facing mining men today

THREE broad advantages of a-c power over d-c for face equipment are as follows:

1. **The a-c system is inherently safer.**
2. **The a-c system is more economical, both in first cost and operating cost.**
3. **The a-c system is more reliable and will supply a higher continuity of service.**

Those who have watched the development of a-c mining over a period of years have seen the development of more rugged motors and control equipment and certain refinements made in the application of relay and protective equipment; however, in all that time the basic protective scheme, both for protection of men and equipment, has remained the same.

Strip Mines Pioneered Basic A-C Protective Schemes

Actually, the basic protective schemes used in a-c underground mining were developed and first put in use in mining in strip pits where the electrification of large strip shovels presented problems in the protection of personnel and equipment.

It was only after a number of electrocutions from contacts with stripping shovels that it was realized that a large electric shovel, sometimes weighing 1000 tons or more, with its steel crawlers or "walking" floats in direct contact with the earth, was a machine that could become hazardous when the insulation of the high voltage motors or the other high voltage equipment on the shovel failed and grounded to the frame.

To limit the ground fault current flow, and hence the drop in potential

across the frame of the machine, the Y-connected primary supply of electric service and the installation of the primary neutral resistor became accepted practice in the strip mining industry.

Today, for any three-phase service in strip mining, a Y-connected power supply is required together with a neutral resistor for all utilization voltages of 150 volts or more above ground. Because of the need for a sturdy and safe high voltage portable cable to supply the electric power to the strip shovels and draglines, the so-called "shovel" or "mine power" cable was developed. This cable, known as type SH-C or SH-D, is manufactured by a number of cable companies and has a tough Neoprene outer jacket with a copper shielding braid or tape over each insulated conductor as well as grounding conductors in the interstices of the cable. This cable is classified as a shielded nonmetallic armored cable.

Federal and State regulations govern the installation of high voltage Neoprene sheathed cables in most mines of the country.

The American Standards Association Safety Rules for Installating and Using Electrical Equipment in and About Coal Mines, and known as U. S. Bureau of Mines Bulletin No. 514, may be used as a guide for selecting the proper type of cable and its method of installation.

Many Companies Are Using A-C for Face Equipment

Major manufacturers have now developed unit substations with transformers of the (1) dry type, air insulated, (2) dry type, completely enclosed in inert gas, or (3) those filled with non-inflammable liquid. These, together with their primary and secondary switch gear, are becoming pretty much standardized so that recently, with the development of the a-c shuttle car equipped with torque converter, the last remaining obstacle to the use of all a-c for underground coal mining was removed.

Today large companies such as Mountaineer Coal Co., Island Creek Coal Co., Kaiser Aluminum Co., Eastern Gas & Fuel Associates, Rochester & Pittsburgh Coal Co., and many others either are already using a-c for face equipment or are planning on its early use.

Because a-c motors are available on practically any kind of mining equipment with the exception of haulage locomotives, any coal company planning on opening up a new mine or expanding operations where new equipment will be required is overlooking an opportunity if it does not investigate the advantages of the use of a-c for face equipment in the new operation.

Every engineer dreams of an opportunity to plan and lay out the electrical system for a new mine, and to select the electrical equipment that will go into this mine. However, he seldom gets a free hand on doing this because of the many things that must be taken into consideration in the planning of the mine, with the cost of the electrical system being only one of the many things that the management must consider in laying out the mining plan and purchase of the equipment.

The writer, if he were planning the development of a large new mine, would use at least 13,200 volts as a service voltage, and probably 4160 volts Y for the primary voltage supplied the transformers for the face equipment. But any mining company should very carefully review all the factors involved in present day practice before purchasing the distribution and transforming equipment to serve the face equipment for the proposed a-c mine.

Overhead and Underground Supply Systems Compared

Let us examine seven mines of Donegan Coal & Coke Co. They have the following supply and face voltages:

One mine has a service voltage of 2400 volts Delta—with M-G sets and 275 volts d-c, and doing conventional mining.

Two mines have a service voltage of 4160 volts Y and are using both Delta and Y-connected transformers to supply 480 volts Y to face equipment.

One mine has a 7200-volt service voltage supplying 7200 volts Delta to 480 volts Y for face equipment.

One mine has 12,000 volts Y to 480 volts Y for face equipment. (Y-Y solidly grounded)

One mine is supplied from a 12,000-volt Y-system but mine transformers convert the 12,000 volts Delta to 480 volts Y.

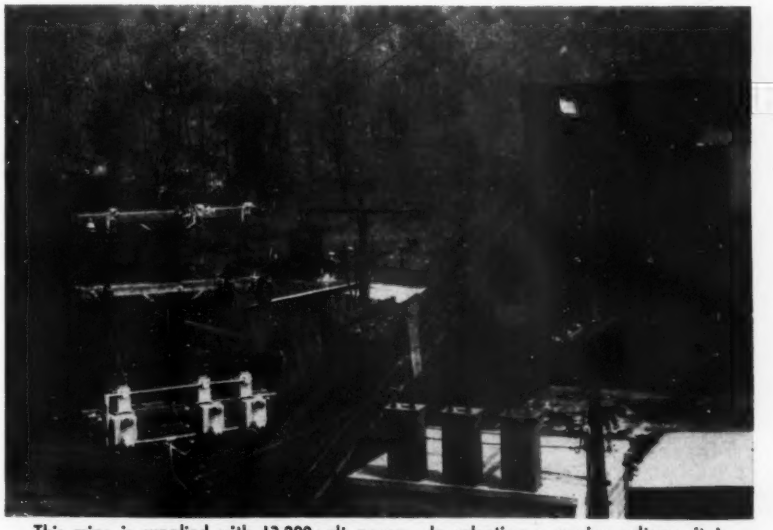
One mine has 12,000 volts Y to 220 volts Delta.

In only two of these mines is the high voltage taken underground. In the other four where a-c is used, 480 volts is taken underground through 500,000 C.M. cables, either through the mine portals or bore holes.

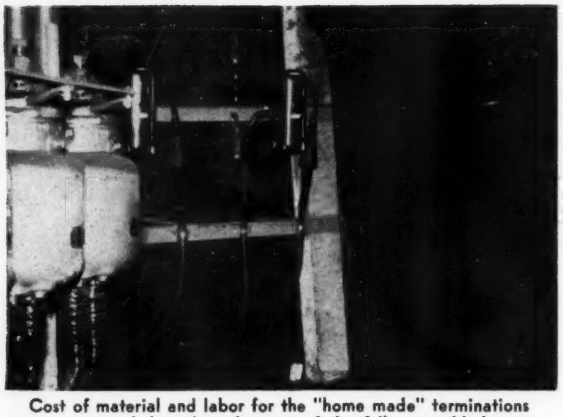
At one of the two mines where high voltage is taken underground, 4160 volts Y is fed a number of substations, some connected Y and others connected Delta on the primary side to 480 volts Y for the face equipment. Ground fault tripping on the face boxes is used. At the other mine 12,000 volts Y is taken underground in single conductor shielded cables.

At both mines single conductor cable is suspended from a catenary messenger wire—⅜ in. 7 strand No. 8 A.W.G. copper weld high strength 30 percent conductivity — which is used as both the neutral return and safety ground system for the mine motors and transformer bank installations. Ground tripping on the face equipment is the universal practice with some neutral resistors in use and more to be installed.

Relative costs of overhead and underground power supply systems should be carefully weighed. Generally speaking, under ordinary conditions overhead lines will only cost one-third to one-half that of underground cable systems. Neglecting right-of-way costs, but including clearing, 33 and 22-kv overhead lines will cost about $8500 per mile and 12-kv lines will cost $6000 to $6500 per mile.



This mine is supplied with 13,200-volt power. In selecting a service voltage, it is desirable to make it high enough to work out the property. With loads of 2500 kw and above, and transmission distances in excess of two or more miles, the voltage should not be less than 13,200



Cost of material and labor for the "home made" terminations was not much less than the cost of the fully assembled pot-heads that came complete from the factory

View shows cables coming out of the oil fuse cutouts and going to the porcelain disconnects and then to the three 100 kva, 13,200 volts Delta to 480 volts Y transformers

In selecting a service voltage it would be desirable to make it high enough to work out the property. With loads of 2500 kw and above and transmission distances in excess of two or more miles, the voltage should not be less than 13,200. Whether the distribution should be overhead and then transformed and taken underground, and possibly with a second transformation, depends on a number of things such as:

1. **Size of mine, system of mining and the transportation system used. These will determine the number and size of the power supply locations required.**
2. **Relative cost of overhead lines and underground cable systems in the areas in question.**
3. **Topographical features of the land overlaying the mine workings and the land use, including ownership, existing roads, housing, streams, accessibility, etc.**
4. **Depth of cover and relative cost of bore holes and overhead lines vs. underground cable systems or with the power supply through the portal entries and bore holes.**
5. **Cost of access road and relative isolation of the service points.**
6. **Weather conditions and altitude of the mine workings.**
7. **Coal seam thickness.**

Donegan Coal & Coke's No. 4, single conductor, 15-kv Neoprene jacketed, shielded, type R.R. grounded neutral cable system costs approximately $3.85 per ft, installed. Its capacity, relatively speaking, is unlimited and one service point is all that will be required to work out the mine.

The firm's No. 2, the 5-kv, single conductor cable system costs approximately $2.85 per ft installed and No. 2 three-phase 5-kv mine power cable will cost approximately $3.50 per ft installed.

At the two mines where Donegan Coal & Coke uses 4160 volts, the 22-kv primary supply line may have to be extended to a new bore hole location when the mine workings have extended out two miles or more from the present workings, but management figures it will have saved enough on its cable system by that time to pay the added cost of a new overhead line and a stepdown substation.

A bore hole, if drilled with a churn drill, will cost approximately $4.00 per ft.

Overhead lines and bore holes have their limitations. They are usually in some out of the way place and are hard to get to. When the snow is 30 to 40-in. deep on the mountain top and the temperature is 10° below zero and trouble occurs to the overhead lines, those are the days management wishes it had those particular lines underground. On the other hand, when a fall occurs in the mine and knocks out the cable system and the trouble is 2000 ft or more away from the nearest transportation and it is in 30-in. coal, the company wishes very much the lines were overhead. Take your choice.

Maintaining Sufficient Voltage Poses Problem

While utility commissions as a general rule will allow an electric utility to supply a service voltage to outlying areas that will have a voltage regulation of plus and minus ten percent, there are very few a-c coal mines that can live with that kind of voltage regulation.

N.E.M.A. guarantees on standard apparatus, especially motors, are for plus and minus ten percent. Thus, if the utility took all the regulation allowed them by the utility commission, it would leave the coal company with very little to go on because, if the voltage falls more than ten percent below the rated voltage of an induction motor, the mine gets into trouble with a-c motor equipment stalling and tripping off the line.

However, since low voltage will cause the motors to stall, the tendency is to have high voltage. As a result there is probably very little a-c coal mine equipment actually operating at all times within the strict limits of its N.E.M.A. guarantees.

While the voltage being supplied by an electric utility is usually thought of as being constant, a graphic volt meter chart placed on a mine's service entrance will soon show otherwise. Therefore, for any new service connection for a-c mining equipment, management should ask its utility company to advise in writing the maximum and minimum voltage, both on peak and off peak, that the utility expects to supply the coal firm over the next five years.

It is somewhat disconcerting for a mine manager to find that he has a 13,200-volt supply on a transformer bank rated, with all taps cut out, at 12,470 volts, and no way to lower the voltage but by bucking transformers. So, if a mine can maintain plus or minus ten percent voltage on its face equipment during all hours of operation, it is doing very well indeed. The average a-c mine will usually start out with some 15 to 20 percent overvoltage and end up somewhere slightly above the lower limits of 10 percent under voltage.

While most equipment manufacturers will not formally approve over voltage on motors, 500 volts on 440-volt motors won't hurt them; although, in case of trouble, the average serviceman will invariably fall back on the N.E.M.A. specifications of their guarantee of plus or minus ten percent as being the outside limits that their motor guarantees will hold.

On the other hand, with 20 percent over voltage the motor heating is 5° to 6°C less and the motor efficiency is as good or better than with normal voltage. High voltage may be hard on incandescent lamps and starter coils but within reasonable limits it won't hurt the motors.

There is one thing that can be con-

sidered axiomatic—an induction motor won't run on much less than ten percent under rated voltage. Of the two evils the writer would rather have high voltage than low voltage. If a company cannot maintain the voltage on its face equipment to between 15 percent plus to minus ten percent, it should consider the use of voltage regulators.

Power Transmission

Considering the relative costs involved for transmission of electric power undeground for coal mining, there is probably nothing safer than the use of the so-called mine power cable.

Until recently it was the general practice to install these cables in the airways, and for a time the only way a high voltage cable could be installed in a manway was to bury it, put it in conduit or use an armored cable. Experience has shown that the cables installed in airways received little attention and that they eventually fail due to falls and lack of attention—for that reason inspectors are now inclined to allow their installation in manways.

Donegan Coal & Coke has been using a-c power for more than 15 years. Most of its coal is thin, around 30 to 40 in. with numerous rolls; thus belt mining is the logical transportation.

The company uses a three to five-entry system, running the belt in the middle entry. High voltage and low voltage cables are put in the belt side of the entry and opposite the manway. By installing the cable in the manway, the cable can always be seen and any conditions observed that might cause a failure to it.

Today's large unit substations pose a problem when most of your coal is 30-in. thick. The development by the electrical industry of the compound filled moulded type of transformer would be a step in the right direction. Donegan Coal & Coke has some of the Class H insulated, totally enclosed nitrogen filled transformers, but they are big and heavy and hard to move. What the company needs is a butel insulated dry type of transformer that can be put anywhere without worrying about moisture and coal dust—one that can be put on a skid and moved without injuring the windings.

Neutral Ground Wire Is Safest Method to Protect Men, Apparatus

Frame grounding for equipment has been a matter of controversy for years and it is doubtful if a fully satisfactory and safe "equivalent protection" device will even be developed to take the place of the frame grounding conductor for d-c equipment. On the other hand, use of the neutral resistor in both the primary and secondary circuits in a-c mining is by far the safest system that has been devised so far and should be universally used in a-c mining. It will protect a man against an insulation failure on a machine provided the ground wire is intact back through the neutral resistor and to the transformer secondary neutral. However, there is no way to protect a man if he should contact a bare place on a trailing cable and be standing in a water hole or in contact with good ground, and get 277 volts phase to ground voltage through his body. A neighboring mine had a fatality of that nature when a man, in dragging a conveyor chain over a trailing cable, made contact with a bare place on the cable.

It is difficult and at times nearly impossible to establish an earthen ground in the mine at the face. As has been proven by several investigators, frame grounding by means of ground rods driven in the mine bottom at the face have proven to be unreliable, and another grounding system such as bonded track, a grounding conductor, etc., have usually been required. However, in the case of the a-c system the use of the neutral ground wire to which all apparatus and transformer neutrals are connected, and this ground wire carried back to the source transformer where it is carried through the insulated neutral resistor to the source transformer neutral, is the safest method yet devised to protect men and apparatus from frame to ground failure of high voltage equipment. By properly selecting the resistance used in the neutral resistors, the voltage a man would be subjected to would not exceed 100 volts for primary equipment (4160 volts) and 25 volts for 480-volt face equipment.

With the use of both primary and secondary neutral resistors, ground fault currents can be limited to selected values and with ground fault tripping, the effect of destructive arcing can be limited.

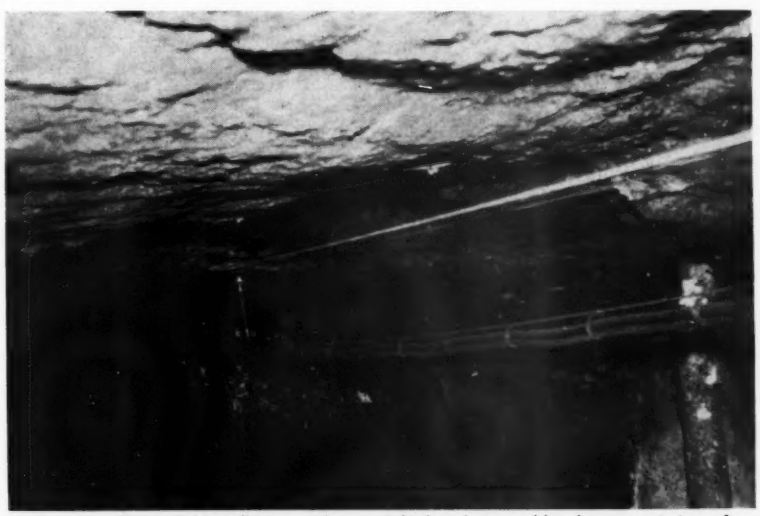
Donegan Coal & Coke has equipped face boxes with ground trip relays that will trip on a ground current of five amps. On the high voltage side the company hopes to clear the circuit with a setting equivalent to a ground current of 15 amps or less through the use of window or doughnut type of current transformers and a primary neutral resistor.

The neutral ground wire or wires can be a part of the mine power type cable or they can be, as at our mines, a ⅜ in. messenger wire copper weld of 30 percent conductivity used both to ground the frames of the equipment in the mines and to attach all the neutrals of the transformers. This conductor is carried back to the substation and attached to the grounded neutral of the step down transformer serving the mine load.

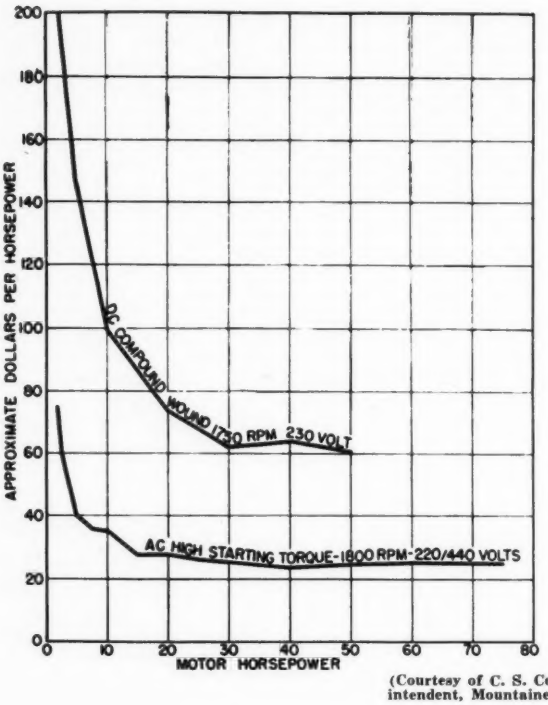
Lightning Protection

Management is planning on keeping the lightning arrester grounds separate from that of the neutral and equipment grounds to prevent a rise in potential on the ground wire running back in the mines in case of lightning coming in on the step down substation.

Management recognizes the superior protection given a substation by oil circuit breakers but where the oil circuit breaker costs more than the substation, the company is in-



An example of the installation and use of high voltage cables for transmission of power in coal mines. The three 13,200-volt No. 4 copper conductor, shielded cables are suspended from a catenary wire supported by roof bolts



Comparison of conversion equipment cost

(Courtesy of C. S. Conrad, Maintenance Superintendent, Mountaineer Coal Co.)

clined to protect the substation with gang-operated oil fuse cutouts, key interlocked with disconnects or couplers, and take the calculated risk of single phasing. The same is true when it comes to surge protection for dry type transformers. With this protection costing as much as one or two transformers in a small substation, management is inclined to take a chance and not equip each of these substations with the highest type of lightning arrester protection.

When high voltage power is taken into a coal mine some means of disconnecting this power must be provided in case of trouble to the power supply in the mine. Donegan Coal & Coke now has one bore hole that is seven miles by road from the pit mouth. The main oil circuit breaker the company is planning on placing at the bore hole will do almost everything but talk. It will be controlled from two points in the mine through an eight-conductor cable that will show on control panels when the breaker is open or closed. A storage battery will be used to trip this breaker, as this is considered the most reliable method of tripping.

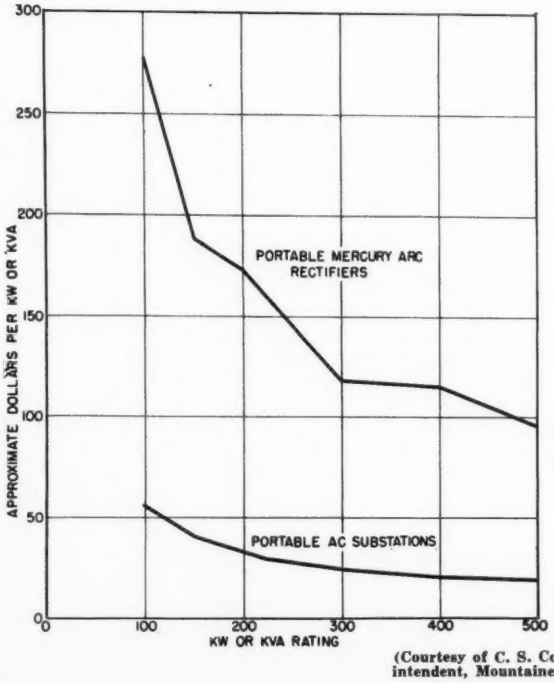


Chart shows approximate cost of corresponding d-c and a-c motors

(Courtesy of C. S. Conrad, Maintenance Superintendent, Mountaineer Coal Co.)

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DISCUSSION

By D. E. HAMILTON

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THE relative advantages and disadvantages of a-c versus d-c have been discussed many times. While everybody who has spoken or written about the subject agrees that the advantages obtained in the use of a-c powered face equipment far outweigh the disadvantages, and while everybody agrees that voltage regulation must be held to closer limits, to date there seems to be little information available on the parameters required to make the most economical selection of power system components.

For instance, there is a tremendous lack of information available on load and diversity factors that are applicable for selection of the proper kva rating of a mine load center to feed a working section. On d-c mine power systems wider voltage regulation bands were tolerated since d-c motors and contactors would operate on low voltage and in general only 2½ times normal current was drawn during starting of the drive or when the mining machinery was encountering hard digging. The only consequence was a decrease in efficiency. On an a-c mine power system, however, if excessive voltage regulation occurs there is going to be a total loss of production due to stalling of motors and dropping out of contactors.

The problem of voltage regulation is magnified with a-c systems due to voltage dips caused by full voltage starting of a-c motors with their inherent inrush currents of six or seven times normal full load current. Some mining operations which are using a-c power at the face use mine load centers rated at half of the connected kva load indicating a diversity factor of approximately 50 per cent. Other mines are using equipment indicating a diversity factor in the order of 75, 80 or even 85 per cent. On the surface it appears that either the first situation is marginal, or else the second situation has idle kva capacity in the mine load center. This illustration serves to point out one of the many diverse factors that should be considered in the selection of equipment for a-c mine power systems.

Voltage Regulation

Another problem is the voltage regulation caused by starting large motors such as the cutter head drive on large continuous mining machines. The effect of starting and accelerating a 200-hp drive, common on many continuous mining machines, can easily require the purchase of an oversize mine load center in order to reduce the effect of the resultant voltage dip on other motors operating off the same mine load center. On some continuous mining machines the cutter head load of 200-hp is furnished by two 100-hp motors operating in tandem. Where this is so, one possible way to minimize the voltage dip when starting this drive is to use only one motor to start and accelerate the cutter head to full speed and then switch in the other motor after the drive has come up to speed. Such a scheme is used on some continuous mining machines. This example is mentioned only to illustrate a factor that might affect the size of a mine load center needed to power a section and to point out that voltage regulation must be examined for both starting and running conditions.

Advantages of Using 6900 Volts for Primary Distribution Voltage

Mr. Huffman has mentioned a number of factors which should be considered in planning an a-c mine power system, especially from the standpoint of laying out the primary distribution system. In his article he suggests that if he were planning a new mine he would use a primary distribution voltage of 4160 volts. For some reason or other, many operators do not even consider 6900 volts for this service. Admittedly on a pure dollar basis, equal size components cost more for 6900-volt systems than their 4160-volt rated counterparts, but on a complete power system basis the cost of the 6900-volt system electrical equipment may in many cases be less than the cost of a comparable 4160-volt system since smaller current carrying components may be required.

The point to remember is that approximately 50 per cent of the cost of an a-c power system is for cable. Any savings that can be made in using a smaller size cable by going to 6.9 kv while still maintaining decent voltage regulation will generally be greater than the added cost of 6900-volt rated switchgear and mine load centers. Today the mining industry has available to it all components required to put together a 6900-volt power system. This includes multi pole cable couplers, switchhouses, mine load centers, system grounding equipment, and cables including the special ground continuity check mine power cables. With the increased loads being concentrated in sections, there may well be a gradual swing to this higher voltage level.

Ground Monitoring Circuit

One point was not mentioned in Mr. Huffman's article in the discussion of grounding. He described the practices associated with grounding of the primary distribution system and the 480-volt utilization system, namely through a continuous metallic ground circuit back to the earth grounding point at the surface substation with the frames of all electrical apparatus connected to this circuit. One point that should be brought out is that the grounding, and hence the safety of the entire mine power system, is dependent upon the continuity of this ground wire. Under normal circuit conditions there is no way of knowing whether this wire is intact until a fault occurs. To prevent such accidents, a simple fail safe circuit has been developed to cause the circuit breaker at the source or supply end of the cable to trip should the ground conductor in the cable protected by the circuit breaker be broken or otherwise made discontinuous. The circuit is essentially composed of a relay, a pilot conductor in the cable, and the ground conductor in the cable all connected in a series circuit through which less than ½ amp of d-c current is circulated. The relay is located at the circuit breaker at the source end of the protected circuit. The pilot and ground conductors in the cable are connected together to complete the circuit only at the end of the cable run. In operation the relay must be picked up, thus indicating continuity of the circuit, before the circuit breaker can be closed. If this circuit is open for any reason at all, such as a broken ground wire or disengagement of a multi pole high voltage cable coupler, the relay will immediately drop out thus opening the circuit breaker. This brief description of the ground continuity check circuit (or ground monitoring circuit as it is sometimes called) is mentioned because of the additional safety it provides to the

(Continued on page 58)

The ABC's of Mine Support

A "mental order" of the factors involved in mine support helps to solve support problems at a particular operation and provides a background for useful exchange of information on the subject

By JERRY M. WHITING

CONSTANT experimentation with various types of mine supports is carried out at each of several mining properties. In many industries this kind of approach to a problem, with its resultant duplication of effort, would lack merit—to say the least. The unknowns of mine support, however, are such that a uniform industry-wide approach cannot be made at this time. Final evaluation of any mine support method can only be made after actual trial. Therefore, the requirements of a particular operation usually must be met by a "custom-tailored" method of support.

Generalizations concerning mine support, especially those involving "ideal" or over-simplified examples, still have their place. They should not be brushed aside with the accompanying phrase, "We have a special problem here!" For it is highly desirable that the individual mining men establish some mental order of the factors related to mine support. Simplified examples often provide a clearer path to solution of the problems encountered at a particular operation, and help develop a background in the subject that aids in exchange of information in the industry.

Relation to Mining Method

The term mining method is an inclusive one which covers all the operations involved in getting rock out of the mine. The mining method in use at any operation is determined by either (1) materials handling requirements; (2) mine support requirements, or (3) a combination of both.

Materials handling requirements: In many operations the grade, size, shape and location of the ore body; the percent extraction required for highest profit, and the daily production goals necessitate a well-coordinated high-capacity materials handling system. In these operations a good portion of the day's work is directed to overcoming difficulties that are a result of physical limitations—the shaft being too small, the haul too long, the ore grade too low, etc. Almost any difficulty encountered means lost time and lost production. In short, they just can't get the rock out fast enough. In this type of operation mine support usually is relatively unimportant. Any support is used that will hold the ground with a minimum of interference to production. The cost of supports is completely secondary to effectiveness and convenience; especially since the amount of support required is apt to be small.

Mine support requirements: On the other side of the ledger are the operations where the mining method completely hinges around support of the ground. Ground characteristics, relative cost and availability of support materials, and prevention of roof falls

Rock bolts are one of the most versatile supports yet devised. In some openings they provide an effective permanent support; in others a safe and economical temporary support; and they are useful for auxiliary purposes, such as hanging pipe, ventilation tubing, and electrical lines

Mine support is of major importance in many underground operations. Often a large part of the crew is engaged in some phase of support work. In fact, methods used to control the ground may determine the whole character of an operation

are of paramount importance. These operations have production problems too, but the main problem is holding the ground *economically*. Sufficient reserves may be available to justify enlarging the shaft, the haulage drifts, the mill; and ore grade may be high enough to allow inclusion of some waste and therefore a faster, unselective mining procedure. But these steps are not feasible since a large part of the crew must be continually engaged in installing thousands of feet of timber, hundreds of rock bolts, or pouring concrete; and mining must be selective to help compensate for support costs and to keep the amount of support used as small as possible. Support costs are so high at these operations that studies are continually made to find cheaper and less labor-consuming ways to hold the ground. A simple, but effective, modification in the support system can mean substantial savings and increased safety for the worker.

Many operations fall somewhere between the two categories outlined above. The two factors, materials handling and mine support, are so interrelated that it is sometimes impossible to say one is more important than the other. It is clear, however, that in many underground mines, mine support is of paramount importance. In fact, the approach to holding the ground may determine the whole character of the operation.

For the rest of this article discussion will be limited, as much as possible, to mine support.

Types of Ground and Load Conditions

First of all, it is well to explain what is meant by *types of ground* so far as mine support is concerned. George J. Young, in his book, "Elements of Mining," has set forth a simple classification of common rock structure, a summary of which follows:

1. **Strong, coherent, no planes of weakness—generally self-supporting—an example would be the limestone deposits in the Metaline Falls district or Tri-State district—miner's term: "solid ground"**
2. **One plane of weakness, such as stratification or sheeting—common in coal mines and other sedimentary deposits — miner's term: "heavy ground"**
3. **Two or more planes of weakness produced by dynamic and structural causes; such as jointing, extensive fissuring, weathering, sheeting in several planes—ground encountered in Butte, the Coeur d'Alenes and many other vein-type deposits would fit into this category—miner's term: "heavy ground"**
4. **Noncoherent, composed of coarse or fine fragments — encountered when traversing overburden or brecciated zones or any other unconsolidated material — miner's term: "loose ground"**
5. **Semiplastic or plastic — clay and other similar rock masses—miner's term: "swelling ground"**

These five types of ground may load a support in any one of the following ways:

A. Vertical (down) pressure only
B. Horizontal pressure equals a fraction of the vertical (down) pressure
C. Horizontal pressure equals approximately the vertical (down) pressure
D. Horizontal pressure predominant
E. Equal pressure on all sides (isotropic pressure)

The most important remaining factors are the nature and magnitude of the load.

Static load: When ground failure occurs mainly as a result of gravitational forces acting on the rock immediately adjacent to an opening, the supports must withstand a *static* load caused by the weight of the rock that has become detached from any natural support. Failure usually continues progressively upward until a natural pressure arch is formed or until a competent stratum is reached.

Dynamic load: When gravitational forces have the opportunity to affect mine workings over a large area due to major planes of weakness, large unsupported excavations, or widespread support failure, a *dynamic* load is created on remaining supports. This dynamic load can cause continual failure that does not stop on its own accord and can produce sufficient stress on unmined portions, such as pillars and walls, to cause rock bursts. A dynamic load also can be created by the release of inherent stresses present in an essentially elastic rock material that has been deformed, within its elastic limits, by geologic forces. Release of these stresses may be sudden, as in rock bursts, or gradual. If the forces are released gradually, failure often stops after a period of time.

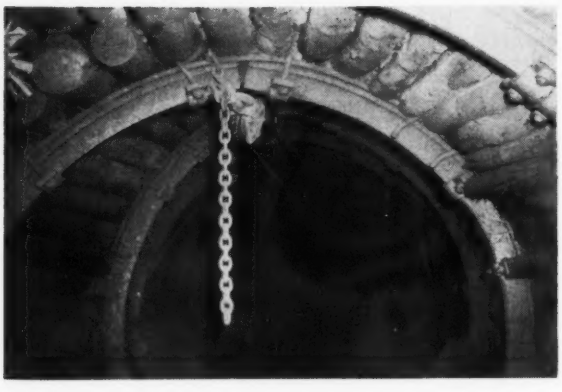
Magnitude of load: Instruments and techniques have been developed, and more are on the way, to determine the magnitude of the load a support must bear. The elaborate steps needed to assure accurate information and the great variation of results within a single mine have limited work along this line, and quantitative data on the magnitude of forces acting on a support are still extremely small. A few comments can be made on the magnitude of forces qualitatively, however.

Static loads, as described above, are generally within the limits that some type of economical support can withstand. Dynamic loads, however, are often too great to be held by any type of support. The best that can be done is to plan mining operations to avoid the possibilities of concentrating stresses or allowing widespread ground movement. A mining method which avoids the use of pillars and keeps open ground to a minimum is most successful. The second alternative, and often the only one possible, is to try to slow the movement and prevent failure of the ground immediately surrounding an opening just long enough to complete production operations which use that opening.

Types of Support

The methods and materials used for

No major support problem here—mining method and sequence are based on materials handling considerations



Forces present in some underground workings are so great that it is impossible for any rigid type of support (above) to maintain openings for their full production period. In such situations yieldable supports (below), which follow a planned pattern of deformation, remain effective much longer. Also, with a gradual release of stress in the adjacent rock, movement often stops before the supports are destroyed

support of workings can be classified as to *types of support* by specifying at least three elements: (1) the general form or use of the support; (2) the material or materials used to make the support, and (3) how the support reacts under load. First, the support's general form or use most commonly is within one of the following categories:

SETS; drift, stope, raise and shaft
STULLS; drift, stope, raise
ROCK BOLTS
LININGS; drift, shaft
PILLARS
CRIBS
FILL

A support may vary in shape or it may be of any size, but in order to classify it accurately as to type, the material comprising the support must be considered. Common materials are:

WOOD
STEEL
CONCRETE
(1) "in situ," or precast (prestressed included)
(2) sand and gravel, or lightweight
MASONRY
WASTE, OR "COUNTRY" ROCK
ORE

Last, but not least, the support's action after installation must be specified to complete tying it down to a particular type—that is, it can be:

RIGID
or
YIELDAGE

The form of support used in any one particular situation is usually pretty well dictated by the kind of opening it has to support. Choice of material depends on cost, availability, and the individual characteristics the material possesses which make its use, in preference to another, advantageous. Thus, wood might be used in one instance because the mine has access to cheap timber; steel in a situation requiring high tensile and bending stresses, concrete where high compressive forces are expected.

One of the most difficult items to assess is whether the support must be rigid or yieldable. Some mining men say, "You can't let the ground move at all, or it'll get away from you." Others emphatically state, "Supports must allow initial movement in order to relieve stress." Obviously they are dealing with different types of ground.

Factors Determining Initial Selection

In the type of ground that produces a static load, the greater number of situations call for a rigid support. The rigid support allows only a minimum of initial movement of the material immediately adjacent to the opening. Thus, ground failure continues only to the point where a natural arch is formed or a competent stratum is reached.

The ideal situation would exist if all supports could be made strong enough to support any load without being deformed. There's just one obvious advantage in having a support yield: Controlled deformation greatly increases the effective life of the support in mines where there are dynamic loads that cannot be resisted by rigid supports. Yieldable steel sets, squeeze blocks, yieldable masonry arches, and cribs deform until stresses in the adjacent ground are relieved; and remain as effective supports during and after the process. In addition, timber sets and rock bolts provide temporary support—often long enough to complete production operations.

There is one rigid support that can resist tremendous dynamic forces—hydraulic fill. Placed immediately after excavation, hydraulic fill prevents initial movement and offers an unyielding support that undoubtedly aids greatly in stabilizing the ground throughout the mining area.

Other important factors in selection of a type of mine support are: (1) cost; (2) performance throughout the operational period; (3) adaptability to mining sequence; (4) post-operational effectiveness, and (5) recovery for re-use. These can be illustrated by two hypothetical examples.

Given: a haulage level in a mine that is relatively dry, but where the original strength of timber is diminished by dry-rot to the point of failure before mining operations are complete. Replacement is expensive. Rock bolts were tried and wouldn't hold in the rock for sufficient lengths of time. The nearest source of sand and gravel is several miles away and the resultant freight charges make the cost per cu yd unreasonable. The answer after careful study is rigid steel sets. Though initially expensive, they retain their strength and are easy to install; there is no replacement work to interfere with mining operations; the level can be kept open for auxiliary purposes after production operations are finished, and the sets can probably be recovered for re-use after they have already served a long and useful life.

In another instance, concrete may be used in a slusher drift, not only because it supports the ground and reduces lost time due to repairs, but because it does not interfere with slushing operations by catching the scraper.

The value of pre-operational information on ground characteristics cannot be overestimated. Location of permanent openings can be made in competent ground where repairs will be at a minimum, and mining method and sequence can be selected to avoid major support problems. Although even the best information may produce some erroneous conclusions, having some sort of over-all support plan is infinitely preferable to doing whatever is expedient after development is completed.

Mine Support Design Considerations

Design of mine supports has to be based on experience and estimates to

a large extent, because many of the variables involved in any mathematical design cannot at present be resolved to any satisfactory degree. Nevertheless, engineering fundamentals and a careful, analytical study of the conditions existing at a mining property can be coupled with experience to form a basis for any design or modification of support and will produce results well worth the time and effort.

An excellent example is the work done by industry, manufacturers and the U. S. Bureau of Mines to find the best methods for anchoring rock bolts and determining patterns and spacing, and to establish certain standards for the manufacture of rock bolts. This work exemplifies experience and engineering working together to provide a type of support that can be used in many mines to reduce costs and increase safety.

Design of sets and linings at a mining property can also be based on a combination of experience and engineering—that is, observations of supports already in use correlated with standard design concepts. The *direction* of load to use in the design can usually be determined after careful observation, and is usually the result of one of the loading conditions set forth in the earlier discussion of types of ground. The *magnitude* of the design load can be approximated by the following method:

Determine the strength of existing supports known to support the ground adequately, and design any new type of support to withstand an equivalent load.

This method affords a direct comparison of the two types of support as to unit cost, unit weight and unit size based on a logical starting point: equivalent design strengths.

In a new mine, where no supports have yet been used, the optimum dimensions for a new support may need to be determined by cut-and-try procedures. A good starting point is to make an estimate of the load, and choose dimensions for the support which will produce the greatest strength-to-cost or strength-to-weight ratio. Where excavation costs are high, efforts should be made to select the material and design the support in such a manner that necessary clearance requirements can be met with a minimum of excavation.

Supports can be designed using either the "safe" stress or "ultimate" stress values found in the design handbooks. Safe strength—ultimate strength divided by a carefully selected safety factor—is a truer representation of the value of the material if long exposure to deteriorating conditions (or rot) is considered.

(Note: This is particularly true in timber support design. The ultimate strength of wood is far greater in comparison to its safe strength than that of steel or concrete. This is because of the safety factor used. A larger safety factor must be used for wood than for steel or concrete because the strength of wood is comparatively unpredictable. Another reason is that the ultimate strength of untreated wood can be greatly reduced within a short period of time due to exposure, aging or rotting.)

Nevertheless, in most instances mine supports are not designed using safe stress values; rather, the supports are expected to be strained past the safe stress values and possibly close to the point of failure for as long as they will stand it. It is, therefore, more realistic to use ultimate stress values in the design of mine supports made of any material—but keeping in mind that the ultimate stress values of wood progressively decrease under conditions found in most underground workings.

Early in the design it must be decided whether or not the support must be able to yield, or follow a planned pattern of deformation, in order to prolong its effectiveness and gradually relieve the stress in adjacent rocks.

Other important factors to bear in mind when designing supports are: (1) cost; (2) strength; (3) the weight of the largest unit of support; (4) size; (5) labor and equipment requirements for fabrication, handling and installation; (6) permanency, and (7) recoverability. The cost of treated timber should always be compared with the cost of rot-resistant types of support. In addition, the possibility of using some type of support, such as rock bolts, as only a temporary measure prior to hydraulic backfilling should not be overlooked.

After the support has been designed and installed, a period of trial must follow. During this period, it can be observed whether or not modifications are needed to increase or decrease the strength of the supports. Strength can be varied by changing the dimensions of the support's cross-section or the distance between the supports.

The use of concrete has been largely limited to cast-in-place lining (left). The future will probably find increased use of precast concrete members—particularly in presently timbered mines where rot is an important factor in support failure (right)

Criteria for Evaluation

Evaluation of mine supports, which most often takes the form of comparisons between two or more types of support, can be divided into two parts.

The first can be called *effectiveness comparisons.* This includes analysis of the relative merits of each of the supports with regard to: (1) strength; (2) safety; (3) permanency; (4) reliability; (5) recovery; (6) ease of handling and installation, and (7)

adaptability to mining sequence. For accurate comparisons the supports must be:

1. **Used under similar conditions**
2. **Designed for the same load (both magnitude and direction)**
3. **Loaded in such a manner that their strength characteristics are efficiently utilized**
4. **Properly installed**

The second part can be referred to as *cost comparisons.* Common units used for cost comparisons are: (1) cost per ton; (2) cost per year of service; (3) cost per linear ft of opening; (4) cost per cu ft of opening; (5) cost per ton of design load, etc. These are usually considered in light of the effect a type of support has on tons of rock produced per man-shift. Each operation must determine which unit or units are the most accurate indication of a support's true cost. Also, a unit that may be an accurate indicator of cost for one part of a mine might not be applicable to another part of the same mine.

Costs used for comparison should be inclusive by taking into account both labor and material for:

1. **Fabrication and preparation**
2. **Handling**
3. **Installation**
4. **Repair**
5. **Replacement**
6. **Recovery**
7. **Indirect costs**

The last item deserves comment. For example, one support system may decrease the accident rate, another type may improve ventilation, and still another type may use a waste product that has caused disposal problems. What these improvements are worth compared to the dollars and cents value that can be assigned to the other items is often difficult to assess.

New Techniques from Research, Engineering and Experience

As mines continue to go deeper, support problems will increase with a corresponding impact on the economics of operation. Research, both basic and applied, offers the mining industry the greatest opportunity to develop effective, economical support systems to meet future requirements.

Fortunately, the mining industry in recent years has greatly increased its pace in research and engineering analysis of its problems—a big step in the right direction. Considerable work is being done to develop instruments and techniques to determine the true nature of ground failure, quantitative values for stress in rock adjacent to mine workings, and magnitude and direction of load that can be applied with confidence to the design of supports. In addition, trials of new types of support at mining properties throughout the country are providing immediate benefits in reduced costs and increased understanding.

The Symposia on Rock Mechanics at Colorado School of Mines are outstanding examples of an approach to understanding the nature of ground failure, so that improved methods can be devised to cope with it. Conclusions derived from the exchange of information between researchers and operators at a meeting such as this may not be immediately applicable to mining operations. However, the build-up of basic knowledge on rock mechanics is sure to provide invaluable information for future mining operations.

Mining men more recently met at the Montana School of Mines for a Hydraulic Stope Fill Symposium. The information exchanged related to practical considerations and, although many questions remained unanswered, the meeting made an immediate contribution to the field of mine support.

The operator and researcher must work together on long-range and short-range programs in order to provide the solution for ground support problems. Both approaches are required for continued success.

Developments in STRIP MINE HAULAGE

An 80-ton capacity coal hauler pays off at an Illinois strip mine. This first-hand report spells out the tractor-trailer's many features and what it has meant to mine operations

By MARTIN R. HECKARD
Superintendent
Rapatee Division
Midland Electric Coal Corp.

MIDLAND Electric Coal Corp. is using what is believed to be one of the largest off-highway trucks in service in the world—an 80-ton capacity bottom-dump truck-trailer unit—at its Rapatee Division in central Illinois. Before discussing this truck, however, let us examine some of the changes that have occurred in the firm's haulage roads.

The mine is located in the heart of the prairie country where the land is relatively level, and the haulage problem consists of lifting the coal from the pit to the top of the surrounding countryside and transporting it into the plant on high speed roads. Early in the firm's truck hauling days roads were narrow, averaging 30 to 35 ft in width, with grades just under the maximum gradibility figures as set forth by the truck manufacturer. However, it was found that these grades increased the time cycle, with a resultant decrease in the raw tons hauled.

Management now uses 2½ percent as a maximum grade, with most of the roads staying within one to two percent. Width of the roads has been increased up to 55 to 60 ft; greater production and safety have more than offset the cost of construction. Roads are built on a well drained subgrade, using 24 to 36 in. of hard shale as a base material. This shale is available in the highwall and is hauled to the roads with the mine's trucks. The shale is covered with a six-in. layer of coarse crushed limestone and sealed off with a thin coat of fine lime rock. This provides a good all weather road—one which enables the firm to haul loads up to 250,000 lb.

Hydrair Units Replace Front Axle

The truck used to haul such loads is believed to be one of the most modern units in the country today. To start with, the tractor does not have a front axle, with a large tubular section which would limit ground clearance to 12 to 14 in. Instead, the wheels are supported on a spindle, which in turn is fastened to a Hydrair assembly. These Hydrair units act as giant kingpins and support the front wheels, while permitting them to be steered. The development and use of this hydraulic shock absorber is one of the greatest features of the truck. Two are used to replace the front axle, two are used to spring the drive axle and two are used for a similar purpose on the trailer axle. With a few minor changes, one of the units is also used as a hitch to fasten the trailer to the tractor.

The Hydrair consists of a heavy hollow casing, which is used as a cylinder, and a movable tubular piston assembly. The chamber in the cylinder above the piston has a layer of oil, for lubrication, and a determined volume of dry nitrogen gas. The piston has a flanged head with an "O" ring seal located in this raised portion, to separate the upper and lower oil compartments. The oil in the lower chamber, on the outside of the piston, is connected to the inside reservoir by a tube with a control valve attached. This valve controls the rate or flow of the oil from the outside of the piston to the inside and makes the whole unit act as a giant two-way shock absorber. Nitrogen gas is also stored inside the piston, so, as the piston comes down and the oil is forced into the interior chamber, a point is reached where the wheel will lift off the ground before a metal to metal contact has been made.

The drive and trailer axle Hydrair units are "ball socket" mounted top and bottom and act as load carriers as well as shock absorbers. The Hydrair used as a hitch carries the empty trailer with six to seven in. of piston exposed. As the load is increased this measurement is reduced until, when fully loaded, only one in. of the piston is visible. This means that the loaded trailer is carried on a cushion of air, and that the shocks are absorbed by this unit rather than being transmitted directly to the tractor. This hitch is located approximately 30 in. ahead of the center line of the drive axle and gives capacity loading of the front tires.

Experimental Engine Rated at 375 Hp

The engine used in this first unit is a Cummins V8 375 hp at 2500 rpm. Because this is an experimental engine and is not available for purchase, all other trucks that Midland buys will use a Cummins V12 engine rated at 425 hp at 2100 rpm. A special cooling fan, made on the design of an airplane propeller, is used with a savings of 66⅔ percent in needed power, or instead of the 30 to 35 hp required to drive most fans, this one runs on ten. Since delivery, the coal firm has installed a thermostatic control on the fan, which cuts it out at all temperatures below 190 degrees. Due to the large capacity of the radiator, a considerable portion of the trip can be made with no horsepower drag due to the fan.

The transmission is a standard Allison Torqmatic model 5840, with four speeds forward and two reverse. This unit does not use a manual clutch and is shifted under full power, in a gear selected by the driver. A converter is used ahead of the transmission, and because a converter has a certain amount of slippage at high speed, a special automatic lock-up is incorporated in the unit in the three forward speeds. The use of the automatic lock-ups was pioneered by Midland; although its controls were crude by today's standards, they are still performing satisfactorily.

The rear axle gearing is the same as is used in the Tournapulls and has performed satisfactorily. Instead of the 12 to 13 gears that are commonly used in planetary axles, this unit has but six gears, with a corresponding increase in efficiency. The axle is held in alignment in the frame by a large ball and socket located on the front end, and a vertical roller running in a guide on the rear which controls side movement. The air brakes are of the multiple disc type

Replacing the front axle, Hydrair units act as giant kingpins and support the front wheels while permitting them to be steered.

and give a total braking area of 6550 sq in. as compared to the firm's other trucks with 1700 sq in. This means approximately four times the safety for the drivers and less chance of equipment being damaged. The tractor has six 18.00 by 25 24-ply tubeless tires, which to date have done a good job. For the maintenance minded, there are no grease fittings on the tractor or trailer other than for the water pump and the two universal joints on the propeller shaft.

Trailer Carries 4.4 Cu Yd Per Ft

The trailer is constructed entirely of Manten S steel to reduce weight. Top and bottom chord members are of box beam construction, with gussets at all joints and corners. The top member is overlaid with an angle for protection against damage from the bucket or door while loading. Sides of the box are of ⅛-in. material, which has been corrugated. These sheets are set with the corrugations at an angle and give the same strength as a sheet of ¾-in thick mild steel. The main wear sheets on the front and back slope of the trailer are 3/16-in. plate, to withstand the loading impact of the first bucket of coal.

Doors on the trailer are 21½ ft long and are hinged front, center and rear. As they drop open, they form a chute and guide the coal into the hopper, thus reducing spillage. The design of these doors and the way they open make it possible to lower the bottom frame of the trailer box, and thereby lower the center of gravity of the entire unit. This also makes it possible to increase its capacity. Where the mine's conventionally designed trailers carry 2¾ cu yd of coal per ft of trailer length, this rig carries 4.4 cu yd per ft. Each door is opened and closed with a two-way air cylinder fastened to a toggle. A long rod also runs from the toggle to the door; as the cylinder moves the toggle, the rod opens or closes the door. This mechanism is located inside the trailer in a wide center cross member, which acts as a brace for the box as well as a protective cover for this linkage. The doors are controlled by the driver from a switch located in the cab.

The trailer axle is a box section built of "T" steel for additional strength with less "dead" weight. In fact, this axle without tires or wheels weighs but 2300 lb. It is fastened to the trailer and held in alignment by two torque members, and uses two Hydrair cylinders to control the load and cushion the shocks. The trailer axle uses four 18.00 by 33 32-ply tubeless tires.

2½ Lb of Payload Per Lb of Empty Vehicle Weight

Midland was interested in carrying the greatest payload with the least possible empty weight, feeling that this would give it the most economical fuel, tire and maintenance dollars. Management was very careful in its inspection of the design not to sacrifice strength or life expectancy, and feels that this goal has been reached. The tractor and trailer weigh 31,000 lb each—for a total of 62,000 lb. The box has a capacity of 100 cu yd, or 160,000 lb of coal, which gives the firm over 2½ lb of payload to each lb of empty vehicle weight. In other words, this unit, which is manufactured by LeTourneau-Westinghouse and sold as their model L. W. 80, has been very satisfactory.

There are no grease fittings on the huge tractor-trailer other than for the water pump and the two universal joints on the propeller shaft

ROTARY DRILLING AND SAMPLING

Modern developments in drilling equipment . . . techniques to overcome difficulties encountered in deep rotary drilling . . . common sampling practices . . . evaluation methods . . . scintillation probing equipment . . .

By E. P. CHAPMAN, JR.
Mining Engineer and Geologist
Chapman, Wood and Griswold

DURING the past several years drilling in search for and the preliminary development of buried mineral deposits has been carried on at a rate unprecedented in mining history. Programs totalling millions of feet have been completed and substantial orebodies have been found.

While this tremendous burst of exploration activity was undoubtedly sparked by the successful drilling and subsequent discovery of major uranium orebodies at Ambrosia Lake, New Mex., and Big Indian Wash, Utah, the search is by no means confined to uranium. Programs seeking copper, iron, boron, potash, manganese and other minerals are being carried out on a tremendous scale. When the footage mentioned in several recent press releases announcing drilling commitments totalling several million ft. in exploration for uranium is added to that being put down and contemplated in the search for other minerals the total is unprecedented and awesome whether it be measured in feet, acres or square miles under investigation, or in dollars of cost.

The accelerated increase in drilling activity has led to great improvements in all types of drilling equipment. Advancements in machinery and techniques have resulted in expanded exploration programs. Among the significant developments in equipment are:

1. The wire-line diamond drill which permits removal of the core barrel while drill rods and bit remain in the hole
2. Scaled-down miniature drills which can be flown to inaccessible areas by helicopter
3. Truck- and track-mounted churn and wagon drills which can be moved from drillsite to drillsite with a minimum of time and road building
4. Combined rotary-percussion systems which permit more rapid penetration with reduced bit wear
5. Improvements in bit and core barrel design and superior alloys

All of these lead to more ft drilled per shift and reduced drilling costs, and all have been described in detail in the literature. Their importance is self-evident when it is realized that each reduction of one cent per ft in drilling cost results in a saving of $10,000 in a million ft program.

When uranium orebodies such as Steen's Mi Vida, Anaconda's Jackpile and Ambrosia Lake were discovered, the mining industry was presented with a new concept in the size of potential targets for exploratory drilling programs. When known Colorado Plateau deposits were limited to narrow, erratic Morrison and Shinarump stream channels, the estimate of possible returns made wildcat drilling beyond 300 to 400 ft economically unfeasible. Even with enough good luck to strike ore early in an exploration program it usually cost more to develop and mine such a deposit than could be realized from it. The large blanket type occurrences with dimensions ranging up to several miles in length, 1000 or more ft in width and 10 to over 100 ft in thickness are a different story. Such deposits containing from a million to tens of millions of tons, can be located and delineated by drilling patterns on comparatively wide centers and can support extremely large exploration programs without jeopardizing satisfactory profit margins. As a result, in geologically favorable areas drilling projects totalling millions of ft to depths up to 2000 ft now may be economically practical under present tax laws.

Difficulties Encountered in Deep Drilling

Early exploratory drilling for uranium was done principally by wagon drills for shallower depths and by rotary rigs of the type used by seismic geophysical crews for the deeper holes (which are shallow by present standards). Cuttings were removed by air sweeping techniques using compressed air and caught in cyclone collectors. As drilling depths increased, equipment and techniques in use proved to be inadequate.

For depths in excess of 500 feet, air is not an acceptable hole-sweeping medium. The volume required is such that compressors with sufficient capacity are not readily portable, and subsurface dampness hampers or stops circulation. While the use of water solves the problem, it creates difficulties of its own. In most portions of the Colorado Plateau water is a scarce commodity and often it is extremely difficult to secure sufficient amounts to sustain an extensive drilling program. When it becomes necessary to use and maintain several water trucks per operating rig and to haul water for 20 or more miles from the closest river, well or stock tank to which water rights can be obtained, this liquid becomes very precious and an important factor in drilling costs.

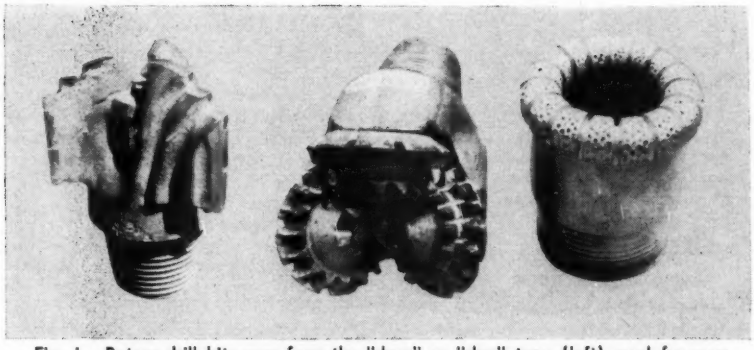


Fig. 1. Rotary drill bits vary from the "drag" or "slug" type (left) used for very soft formations, such as mudstone and shale, to the various types of tri-cone roller bits (middle) and coring bits (right)

When water is introduced into certain of the bentonitic mudstones and shales common in the Brushy Basin Member of the Morrison Formation, the Chinle or the Wind River, conditions are created under which holes cave badly and may be lost entirely. Soft sand formations tend to wash excessively (contaminating samples from underlying strata), soak up precious water, and cave. Water courses, faults and shattered zones often result in loss of circulation.

When alternate hard and soft formations are encountered, drill pipe will tend to bend in the washed-out enlarged hole of the softer strata when sufficient top hole weight is applied to penetrate the harder rock. This results in excessive whip in the drill stem, uneven pipe wear and eventually in twist-offs. The author has seen three rigs on one project simultaneously fishing for twisted-off drill strings. After 36 hr of fishing all three holes were abandoned with over 1000 ft of pipe in the ground. The effect of such occurrences on drilling costs can well be imagined.

Oil Field Techniques Adopted

These problems are identical to those encountered by the large diameter oil well rotary rigs, and in solving them drillers have adopted techniques long practiced in the oil fields. Hole walls are stabilized and cave-ins reduced by the use of drilling mud and by round-the-clock drilling which eliminates the harmful wet-dry cycle resulting from single shift operation and reduces to a minimum the time between opening up of troublesome formations and completion of the hole. Bran and other materials which swell rapidly when wet overcome many circulation problems. The whip action of drill strings can be partially controlled by using heavier, less flexible pipe and employing drill collars. The added weight of such equipment permits reduction in the application of top hole weight without sacrificing the bottom hole bit pressure which produces rapid penetration. A typical deep hole rotary drilling outfit complete with 300 to 500 cfm compressor and positive action water pump is compactly mounted on a large diesel driven truck. The mast, which can be raised and lowered hydraulically, is from 25 to 40 ft above the rotary table and equipped with a high platform or "monkey board" to permit breaking the drill string in longer lengths and stacking the pipe vertical during trips. Water is circulated through two pits, one for settling overflowing into the second which serves as a pump sump. Bentonic drilling mud and lost circulation material such as bran are added directly to the sump pit and mixed by hand.

Drill bits vary from the "drag" or "slug" type used for very soft formations, such as mudstone and shale, to the various types of tri-cone roller bits. (See Figure 1.) In hard rock areas tooth and roller design are very important. For example, at Ambrosia Lake in New Mexico a hole can often be drilled through the lower Mancos shale, the Dakota sandstone and the Brushy Basin and Westwater Canyon Members of the Morrison Formation to a depth of 700 ft with one tri-cone bit costing approximately $60. In certain areas of Colorado and Utah it may take 25 of the same bits to cut the same formations to the same depth. In some instances switching to bits utilizing harder alloys and different roller and tooth design, but each costing $125, can cut the bit consumption by more than 50 per cent. However, it is interesting to note that in soft formations the hard formation bit is entirely unsuitable. Mud will clog and mask cutting teeth, penetration rate will drop drastically and bit wear per ft will be excessive.

Proper Evaluation of Drilling Information Vital

At best, deep hole drilling programs are very expensive. Even with large targets, major deposits can be missed entirely if first stage hole spacing is one at centers much greater than 500 ft. When the area under exploration totals several sections, several hundred holes would be required initially. If mineralization is encountered, closer spaced holes should be put down to delineate the deposit and determine its thickness and grade. The drilling portion of such an exploration and development program alone may total a good many hundred thousand feet at a cost ranging from $750,000 to over $1,000,000. Subsequent shaft sinking underground development costs would bring the total investment before a pound of ore reaches the surface to several million dollars. Under such circumstances, the importance of properly evaluating drilling results cannot be overemphasized.

The fact that uranium and its daughter products are radioactive, permits utilization of evaluation techniques unavailable in the exploration

Fig. 2. Both the electronic circuit and motor driven reel of this scintillation gamma logger and recorder unit operate on the vehicle's 12-volt system

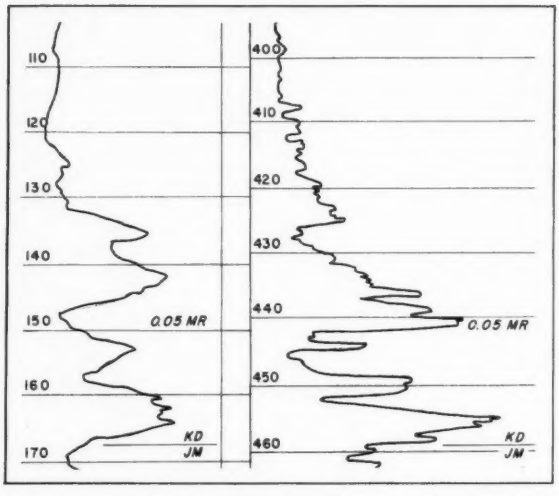


Fig. 3. When a hole is probed, the recorder produces a log which, in the higher sensitivity ranges, gives an excellent lithologic picture of the hole. Shown are the logs of two holes 1000 ft apart. An analysis of these logs indicates they have both intercepted the same formation contact at a difference in elevation far in excess of that expected from surface geology observations

for other metals and minerals. This permits use of higher-speed, lower-cost open hole drilling in the preliminary or wild cat stage of an exploration program with little or no danger of overlooking significant uranium mineralization. However, it is imperative to keep constantly in mind that radiation measurements must be correlated with chemical assays on samples before they can be accepted as more than mere indications of grade. The radiometric to chemical ratio varies widely from district to district, from orebody to orebody within a district and even from hole to hole within an orebody.

Core samples with a high rate of recovery form the only satisfactory base from which to properly calibrate probing instruments and to interpret radiometric readings. Sludge or cuttings samples are very helpful in giving a generalized picture of the column penetrated by a hole. However, certain unavoidable factors contribute to their over-all unreliability. These include:

1. Contamination: soft strata, once penetrated, will often continue to wash despite hole-wall mud coating. Cutting samples from intervals of Todilto limestone have been observed containing as much as 40 percent sand. Cores showed the limestone to be sand free. Contamination had come from the overlying Bluff.

2. Time lag: at depths over several hundred feet there is a considerable time interval between production of sludge at the hole bottom and its appearance at the surface. The time is a function of volume of slurry being pumped, annular area of the hole about the drill string and hole depth—it is not a constant.

3. Loss: in the thickened drilling mud slurries used as drilling fluids, fine particles tend to stay in suspension and escape the sample settling box or area. Since uranium minerals tend to be much softer than the rock which surrounds them, evidence of mineralization can be, and often is, entirely missing in sludge samples.

Core samples are taken in the manner common throughout the mining industry. Since uranium deposits are often in soft, loosely consolidated sands, care must be exercised if recoveries are to be acceptable. Large core diameter, proper rotation speed and bottom hole pressure, plus the use of the modern types of core barrels, all contribute to recoveries averaging over 90 percent. Although special techniques, such as freezing, are sometimes required, they have been, at least to date, the exception.

Determination of Hole Pattern and Spacing Greatest Problem

Perhaps the greatest problem in the evaluation of a mineral deposit from drilling results is the determination of the hole pattern and spacing required to sufficiently delineate an orebody to permit classifying it as "proven." During the past year many "drilled out" deposits have been

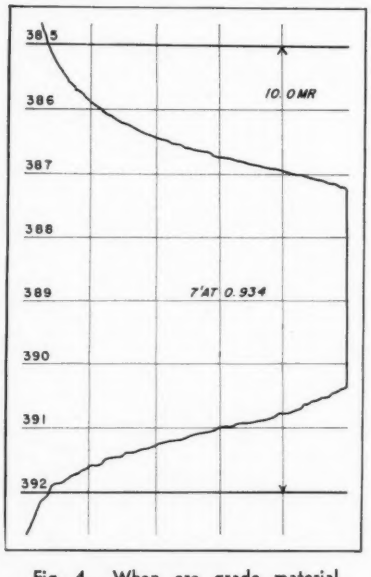


Fig. 4. When ore grade material is encountered in any hole, an expanded scale log is run. Radiometric assays determined from this type of log have been checked in many instances with chemical assays and the results have been uniformly satisfactory

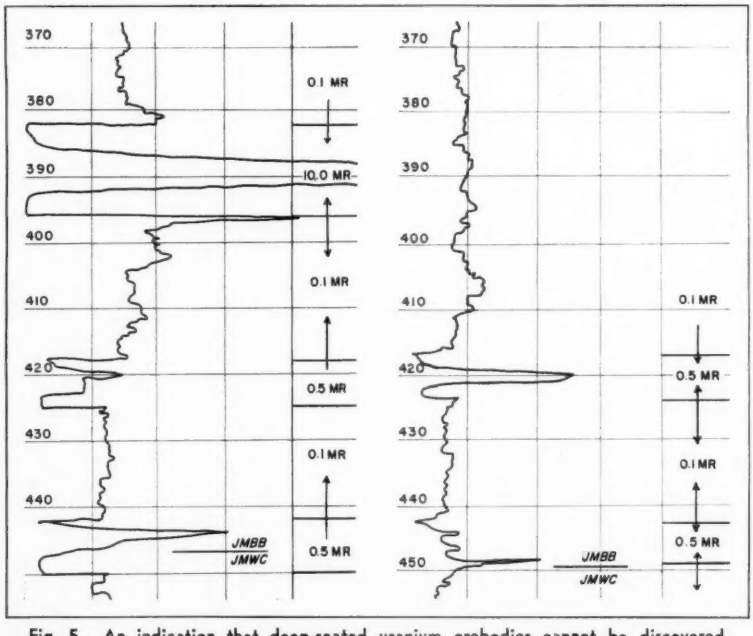


Fig. 5. An indication that deep-seated uranium orebodies cannot be discovered by the use of scintillation equipment at the surface is afforded by the two logs shown here. High grade ore is recorded between 385 and 392 ft on the log at the left, but there is no indication of mineralization on the right hand log although the two holes were separated by only 12.5 ft of porous sandstone

opened up by development workings and exploration engineers have had the opportunity to check the validity of their ore reserve estimates based on drill results. Unfortunately, there have been many instances in which orebodies have been found to vary considerably from what had been considered to be conservative estimates. The discrepancies have been, for the most part, the result of an insufficient number of holes rather than improper evaluation of available data. There is no rule of thumb by which the evaluation engineer can safely say in advance what hole spacing may be required to block out any specific type of mineral deposit. It is true that if drilling is carried out on closer and closer centers until intermediate holes no longer result in more than minor changes in tonnage and grade calculations or in the estimated shape and attitude of the orebody, estimations can be considered reliable. However, if mineralization is erratic and spotty, characteristics of most uranium deposits, such a procedure may raise exploration costs beyond the limit of economic feasibility. In such cases, a compromise must be reached carefully weighing the safety resulting from expensive additional drilling against the risk of even more costly capital outlay for mine development on a partially proven orebody.

Scintillation Probing Equipment

The radiometric logging of drill holes is a somewhat controversial subject. Instrumentation, calibration techniques and methods of interpretation vary widely. While excellent evaluation jobs have been done with simple Geiger counters and hand operated reels, there is no doubt that the recording scintillation probing unit is well worth either the considerable difference in initial cost or the price of contracting for the logging service. The scintillometer's faster reaction time speeds logging. Its greater sensitivity results in a record from which much useful lithological data can be deduced.

There are many excellent gamma logging units in use. One which the author and his associates used successfully for several years is described below and shown in Figure 2.

The unit is a Moran SLMR 1000 Scintillation Gamma Logger manufactured by the Moran Instrument Co. of Pasadena, Calif., coupled to a Welltab recorder. It is mounted in a station wagon. Both the electronic circuit and the motor driven reel operate on the vehicle's 12-volt dc battery-generator system.

The unit is field calibrated with a radioactive ring placed at the most sensitive point on the probe. The proper value for the ring is predetermined in the Moran factory, checked in our own laboratory and constantly rechecked by probing holes from which core has been taken for radiometric assay.

When a hole is probed, the recorder produces a log in which the vertical scale is one inch to 10 ft and the horizontal scale is dependent upon the sensitivity setting used. Six such settings are available ranging from 0.05 to 10 milliroentgens per hr. At equilibrium calibration, milliroentgens per hr divided by 10 is equal to percent e U_3O_8.

In the higher sensitivity ranges (or at the low mr/hr settings) the log gives an excellent lithologic picture of the hole and enables accurate determination of formation contact. An example is shown in Figure 31—the reproduction of logs of two holes 1000 ft apart in Colorado. Logging of cored holes had previously shown the relationship between a sand-shale lithofacies change in the Dakota and the Dakota Morrison contact—appearing in both logs as a double step reduction in radiation intensity. The hole represented in the left-hand log had been drilled first and the contact found at a depth of 167 ft. From projection of surface dips it was anticipated that the contact would be approximately 100 ft deeper in the second hole. Cuttings samples were so poor because of high mud density that they were practically useless in determining drill position in the stratigraphic column. It was not until the hole had been stopped and the gamma log run that the base of the Dakota was realized to be 200 ft lower than expected, and that the hole had to go deeper to encounter the potential ore horizon. A fault lying between the holes had a much greater throw than expected.

When ore grade material is encountered in any hole, an expanded log is run in which the vertical scale is one in. to one ft through the ore zone. Thickness and grade estimations are made by:

1. Choosing ore limits on the expanded log
2. Determining the area within the curve in ore zone by means of a planimeter
3. Dividing the area by the thickness of the ore zone

The result is the average intensity in mr/hr which when divided by 10 gives percent e U_3O_8. Where equilibrium unbalance is a factor, and it usually is, a correction factor must be applied to give an approximation of chemical grade.

Several thousand holes have been evaluated by this method. Of these approximately 10 percent have been cored through the ore horizon and radiometric and chemical assays run to give conclusive data for checking purposes. Results have been uniformly satisfactory.

The log reproduction in Figure 4 shows an expanded log through seven ft of high grade ore at Ambrosia Lake. The grade here was such that the recorder went offscale for 3.2 of the 7 ft. Evaluation of this log showed seven ft at an average of 0.973 percent e U_3O_8. Core assays gave eight ft at 1.352 percent e U_3O_8 radiometrically, and eight ft at 2.503 percent U_3O_8 chemically. This is the widest divergence in logging and core results which the author has encountered in any hole. The high grade is obviously the cause and fortunately the divergence is in a conservative direction.

Much More Yet to Learn About Uranium Exploration

There have been many claims that deep-seated uranium orebodies can be discovered by the use of scintillation equipment at the surface. The two log reproductions in Figure 5 show that this is highly improbable, if not utterly impossible. The one on the left shows the regular scale log of the hole just discussed. The seven ft of high grade ore is shown between 385 and 392 ft. The right hand log is from a second hole drilled just 12.5 ft away. In the potential ore horizon there is not the slightest indication of mineralization although all that separates the two holes is 12.5 feet of porous sandstone.

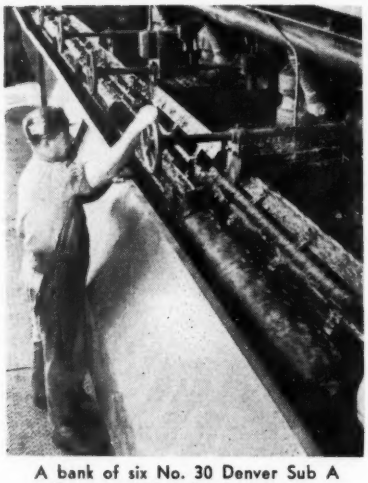
Many of the facets of drilling and evaluation have not been touched on here. Things such as thorough washing of holes to minimize the plastering effect of high grade cuttings and the probing of holes as soon as possible after completion to avoid the effects of radon gas migration are important, but should by now be common knowledge.

Electric and self potential logs, long used to great advantage in the exploration for oil, can furnish much useful data concerning porosity and permeability helpful in the search for minerals. These and other geophysical techniques are finding increasing use in mineral exploration.

Much has been learned about uranium exploration during the past few years and there is much more to learn.

It seems safe to say that with the volume of deep drilling going on a number of new districts and major orebodies will be discovered. If forecasts as to the potential demand for metals by people who should know are correct, even the present tremendous effort must be increased in spite of the current discouraging market characteristics. Many of the most successful mining men in history made fortunes by discovering and acquiring mineral deposits in times of depressed prices and having them ready for exploitation when prices were high. If their example is to be followed, the time to search is now. To keep pace, our drilling and evaluation techniques must and will continue to improve.

FINE COAL PREPARATION AND CLOSED CIRCUIT OPERATION



A bank of six No. 30 Denver Sub A cells was installed. Reagent consumption averages about 0.1 lb per ton of clean filter cake

The introduction of froth flotation to beneficiate coal fines and the resulting reduction in circulating solids added up to an increase in over-all efficiency at a 400 tph coal preparation plant in southeastern Pennsylvania

By M. C. CHANG
Research Mineral Engineer
Central Research Laboratory
Crucible Steel Company of America

THE question of what to do with coal fines has been a problem to the coal industry and particularly to the operators of coal preparation plants. In general, the fine coal slurry in the plant is disposed of either by rejecting it as waste or by filtering it (sometimes after size classification) to recover the unbeneficiated solids in the slurry. These methods leave much to be desired. The rejection of the slurry as waste means loss of coal value and requires a large area of land for impounding purposes. The recovery of the unbeneficiated fine solids as filter cake provides a high ash product which is unsuitable for metallurgical use.

PROBLEMS

The Crucible Mine, located at Crucible, Pa., has a production capacity of 5000 tpd. The coal preparation plant, which was built in 1943 by Roberts and Schaefer, has a rated capacity of 400 tph. The plant consists of hydroseparator boxes to wash the 4 by 1-in. and 1 by 5/16-in. coal and hydrotator units, with a classifier concentrator, to process the minus 5/16-in. coal. A detailed flow sheet of the coarse coal circuit accompanies this article. Prior to the changes which resulted in the present circuit, the fine coal slurry (predominantly minus 24-mesh material) was recovered by processing it through a battery of five 14-in. and one hundred and ten 3-in. Heyl & Patterson cyclones in parallel with a 75-ft Dorr thickener; two-thirds of the volume went to the cyclones and the remaining one-third to the thickener. Underflows from the cyclones and the thickener were filtered, respectively, in one 12-disk Eimco and two 4-disk Oliver filters fitted with stainless steel cloth (40 by 60-mesh). The resulting cakes were added to the coarse metallurgical coal. Overflows were recycled to the coarse coal section of the plant. A flow sheet of this fine coal circuit also accompanies this article.

Initially the filter cake contained only about 12 percent ash, and it was possible to tolerate this type of system. However, to reduce the mining cost, the operation was switched from the track-mounted mining machinery to the more efficient off-track equipment. With this operational change the following problems were encountered:

(1) Ash content of the filter cake went as high as 18 percent. The addition of ten percent of this high ash and moisture material to the coarse metallurgical coal, compounded by the lack of blending facilities at the mine, degraded the quality as well as the uniformity of the product which was to be charged to Crucible's coke ovens. The undesirability of this filter cake was verified by a test, extending over a period of two months, to exclude it entirely from the metallurgical coal.

(2) Daily slime bleed in the form of retained dirty moisture in the coarse coal products and filter cake was not sufficient to offset the incoming fines in the raw coal feed. Therefore, an excessive buildup of slimes was created in the circuit. Each weekend it was necessary to purge the system by pumping the solids in the thickener to a waste pond. However, the slimes built up during the week and caused the apparent density and viscosity of the circulating plant water to increase progressively. As a result, the hydroseparators and hydrotators had to be adjusted frequently thus making the operation of the coal washing plant extremely difficult. The yield, quality, and uniformity of the product therefore suffered. The ash content of the metallurgical coal actually varied from 8 percent to as much as 12 percent.

(3) The geographical location of Crucible's plant does not allow unlimited waste pond space. To maintain a waste pond for the purpose of emptying the thickener every weekend became a costly burden.

Size and ash distribution of the cyclone and thickener underflows which constituted the filter cake product under the old practice are given in table A.

TABLE A

Size and Ash Distribution of Cyclone and Thickener Underflows (Old Practice)

Size Mesh	14-In. Cyclone Underflow (55.8% solids) Wt. (%)	Ash (%)	3-In. Cyclone Underflow (41.9 % solids) Wt. (%)	Ash (%)	Thickener Underflow (53.3% solids) Wt. (%)	Ash (%)
+24	36.1	7.80			13.7	6.28
24/48	30.0	8.75	4.8	4.36	47.0	9.08
48/100	14.2	15.53	38.6	7.59	17.5	15.98
100/200	5.0	25.61	33.0	15.32	17.1	22.00
—200	14.7	42.75	23.6	32.80	4.7	26.16
Composite	100.0	15.21	100.0	15.94	100.0	12.92

TABLE B

Size and Weight Distribution of Cyclone Feed and Products*

Size Mesh	14-In. Cyclone (Wt. %) Feed (8.3% solids)	Underflow (58.9% solids)	Overflow (4.8% solids)	3-In. Cyclone (Wt. %) Underflow (21.6% solids)	Overflow (2.7% solids)
+16	2.53	7.07			
16/32	4.11	13.50	0.50	0.83	0.08
32/60	11.74	34.80	0.96	2.16	0.25
60/100	12.64	22.12	3.41	6.83	0.93
100/140	6.19	5.91	3.64	6.47	1.03
140/200	7.68	6.24	6.55	12.80	2.01
200/325	7.11	3.02	9.26	16.60	2.54
—325	48.00	7.34	75.68	54.31	93.16

* Prior to installation of 24-in. cyclone.

M. C. Chang's experience includes four years as a research fellow at Massachusetts Institute of Technology, doing fundamental research in the mechanism of flotation process, and three years as a research associate at the University of Minnesota where he worked on beneficiation of iron ores. From 1954 to 1955 he served as section head of the Metals Group, Chemical Construction Corp., directing and coordinating research and development work in the fields of hydro and chemical metallurgy. Since 1955 he has been associated with Crucible Steel Company of America.

IMPROVEMENTS

To overcome these difficulties, several changes, which emphasized the use of existing equipment, were made in the plant. These changes included series operation of the cyclones and thickener, flotation of the cyclone underflows, filtration of the thickener underflow, replacement of the classifier with a 24-in. cyclone. The revised flow sheets of the coarse and of the fine coal circuits accompany this article and the details of the changes are presented in the following.

Series Operation of Existing Cyclones and Thickener

The cyclones and the thickener were arranged in series. The fine coal slurry was first classified through the cyclones and the final overflow was discharged into the thickener. Prior to the installation of the flotation units, the cyclone underflows were filtered in the 12-disk filter and the cake was added to the coarse metallurgical coal. The thickener feed was flocculated with causticized potato starch to provide clear thickener overflow for recycle and the underflow was temporarily disposed of by pumping it to a waste pond.

Performance of the cyclones is illustrated by the size and weight distribution of the feed and products given in table B.

Approximately 25 percent of the feed was rejected in the final overflow. Subsieve sizing of the solids in the final overflow showed that 92 percent was finer than 600 mesh. This circuit arrangement made some improvement in the quality of the metallurgical coal; however, the most striking observation was that the tonnage of the fine coal was reduced from as much as 45 (filter cake) to not more than 33 dry tons per hour (filter cake and thickener underflow). The mining practice was not changed when the circuit was rearranged, therefore, the quantity of fines in the raw coal feed could not have fluctuated too widely. The solid contents of the recycled water were reduced from about 13 percent to 0. There was also a substantial reduction of the solid contents in the classifier and settling tank overflows which made up principally the slurry feed to the fine coal circuit. The solids in the classifier overflow were reduced from 23.5 percent (of which one-fifth was coarser than 32 mesh) to 8.8 percent (of which essentially all was finer than 32 mesh). The settling tank overflow previously contained 18.3 percent solids of which 92 percent was minus 32 mesh; after the change, the overflow contained only 3.6 percent solids of which 4 percent was coarser than 32 mesh. Since the volume of the slurry in the plant did not change, it was apparent that during the old practice much of the plus 32-mesh material was recovered in the fine coal circuit. After the solids in the recycled water were removed, most of this material was reporting in the classifier. This was substantiated by the fact that the overload in the classifier unit caused it to perform poorly and stall frequently.

Another significant observation was that the quantity of the steam coal produced was reduced from 14 to 5 percent of production.

Flotation of Cyclone Underflows

A bank of six No. 30 Denver Sub A cells was installed. Each of the cyclone underflows was floated separately in a three-cell unit. The flotation circuit has a total capacity of about 20 tph of clean coal. Maximum capacity of the cell is about four tph of clean coal for the 14-in. cyclone underflow and about 2.7 tph for the three-in. cyclone underflow. The feed is maintained at about 20 percent

TABLE C

Size and Ash Distribution in the 14-In. Cyclone Underflow Flotation*

Size Mesh	Weight (%) Feed	Concentrate	Tailing	Ash (%) Feed	Concentrate	Tailing
+16	7.07	3.13	11.40	6.72	6.08	6.96
16/32	13.50	10.20	10.70	7.48	4.92	10.20
32/60	34.80	33.16	15.73	9.60	4.88	15.40
60/100	22.12	29.30	12.23	10.56	5.24	27.60
100/140	5.91	9.00	5.94	17.16	5.80	40.70
140/200	6.24	8.35	7.25	23.84	8.12	56.80
200/325	3.02	2.90	7.55	42.68	17.16	72.00
—325	7.34	3.96	29.20	60.96	33.88	79.64
Composite	100.00	100.00	100.00	15.1	7.4	43.8

* Prior to installation of 24-in. cyclone.

TABLE D

Size and Ash Distribution in the 3-In. Cyclone Underflow Flotation*

Size Mesh	Weight (%) Feed	Concentrate	Tailing	Ash (%) Feed	Concentrate	Tailing
+32	0.83	0.27	0.85	6.36		
32/60	2.16	1.28	2.23	5.72	2.90	6.25
60/100	6.83	6.40	6.85	4.20	2.34	5.30
100/140	6.47	6.90	6.29	4.28	2.70	6.00
140/200	12.80	14.05	9.53	4.56	7.48	6.90
200/325	16.60	19.40	12.00	5.00	3.44	7.80
—325	54.31	51.70	62.25	31.72	10.88	62.08
Composite	100.00	100.00	100.00	19.3	9.00	40.9

* Prior to installation of 24-in. cyclone.

solids. Reagents used are Aerofroth No. 73 for the 14-in. cyclone underflow and methyl isobutyl carbinol for the three-in. cyclone underflow. The reagent consumption averages about 0.1 lb per ton of clean filter cake. The froth product filters readily and is handled in one 4-disk Oliver filter. Tailings are discharged into the thickener for dewatering and disposal.

Size and ash distribution of the feeds, concentrates, and tailings of the flotation units are given in tables C and D for the 14-in. and 3-in. cyclone underflows, respectively.

The weight recoveries were 85 to 90 percent for the 14-in. cyclone underflow and 80 to 85 percent for the 3-in. cyclone underflow.

It may be noted here that a good separation (concentrate containing less than about ten percent ash) was obtained only in the plus 200-mesh fractions in the 14-in. cyclone underflow. The presence of the plus 65 mesh, however, was undesirable since the recovery for this size fraction was poor. For the three-in. cyclone underflow, a good separation was extended to the minus 325-mesh but deslimed fraction. This signifies the importance of feed classification for efficient separation by flotation.

Disposal of Thickener Underflow by Filtration

The thickener feed now consisted of the flotation tailings and the three-in. cyclone overflow. The solids were flocculated by the addition of caustic-ized potato starch at the rate of about 0.6 lb per ton of solids. The lack of waste pond space made it necessary to filter the thickener underflow. The 12-disk Eimco filter was fitted with polyethylene bags and used for this purpose. The cake refuse containing about 40 percent ash and 35 percent moisture was combined with the plant refuse for disposal via aerial tram buckets to the refuse pile located across the Monongahela River.

Size and ash distribution of the cake refuse are given in table E.

TABLE E

Size and Ash Distribution of Fine Refuse*

Size Mesh	Weight (%)	Ash (%)
+16	2.50	8.60
16/32	3.10	13.60
32/60	4.67	22.88
60/100	6.25	28.64
100/140	3.61	31.56
140/200	5.43	57.32
200/325	6.85	39.44
—325	67.59	54.72
Composite	100.00	38.9

* Prior to installation of 24-in. cyclone.

Replacement of Classifier With 24-In. Cyclone

When the feed to the classifier concentrator was sampled, it was found that the plus 28-mesh fraction contained about eight percent ash. To overcome the poor performance of the classifier and to eliminate the presence of plus 28-mesh material in the flotation feed, the classifier was replaced by a 24-in. cyclone which handled not only the former classifier feed but also the settling tank overflow. The cyclone underflow was wet screened at 28 mesh with the undersize and the overflow going to the 14-in. cyclones. By this arrangement it is expected to improve the recovery of the 10 by 28-mesh coal as well as the performance of the fine coal circuit. This installation is relatively new; therefore, no data are available at this time for evaluation.

A few other changes were made in the plant prior to the installation of the 24-in. cyclone. The raw coal screens were equipped with water sprays to provide better sizing of the feed to the hydroseparator units. This also made possible the elimination of one raw coal screen thus reducing the number required from three to two. The CMI dryer effluent was returned to the settling tank instead of going directly to the fine coal circuit. A crusher was installed to crush the coarse clean coal through two in. to minimize the tendency of size segregation in the barge.

RESULTS

Results discussed in this section are based on data obtained before the installation of the 24-in. cyclone.

Performance in Coarse Coal Circuit

The change in practice has improved the performance of the coarse coal circuit. This is illustrated by the improvement in the ash analysis of the products obtained from each of the washing units during the first half of 1956 and the second half of 1957 (table F).

TABLE F

Ash Analysis of Products of Coarse Coal Washing Units

Washing Unit	Ash in Product (%) Old Practice (1956)	New Practice (1957)
Hydroseparator (4 by 1 in.)	8.33	7.00
Hydroseparator (1 by 5/16 in.)	8.87	8.79
Hydrotators	7.95	7.82

Ash content of the final plant refuse during those periods was increased from 66.9 to 69.0 percent.

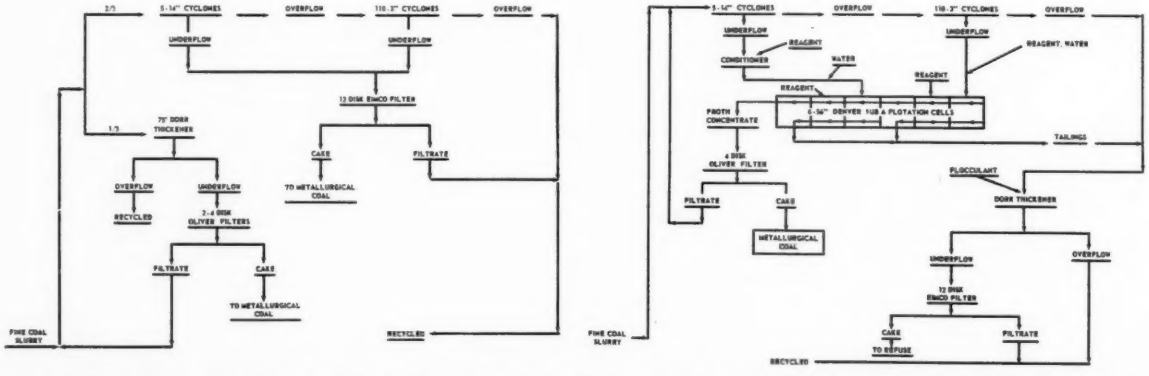
Filter Cake Quality

The upgrading in the quality of the filter cake resulted from beneficiation by flotation and can be described in the average analysis of the various filter cakes given in table G.

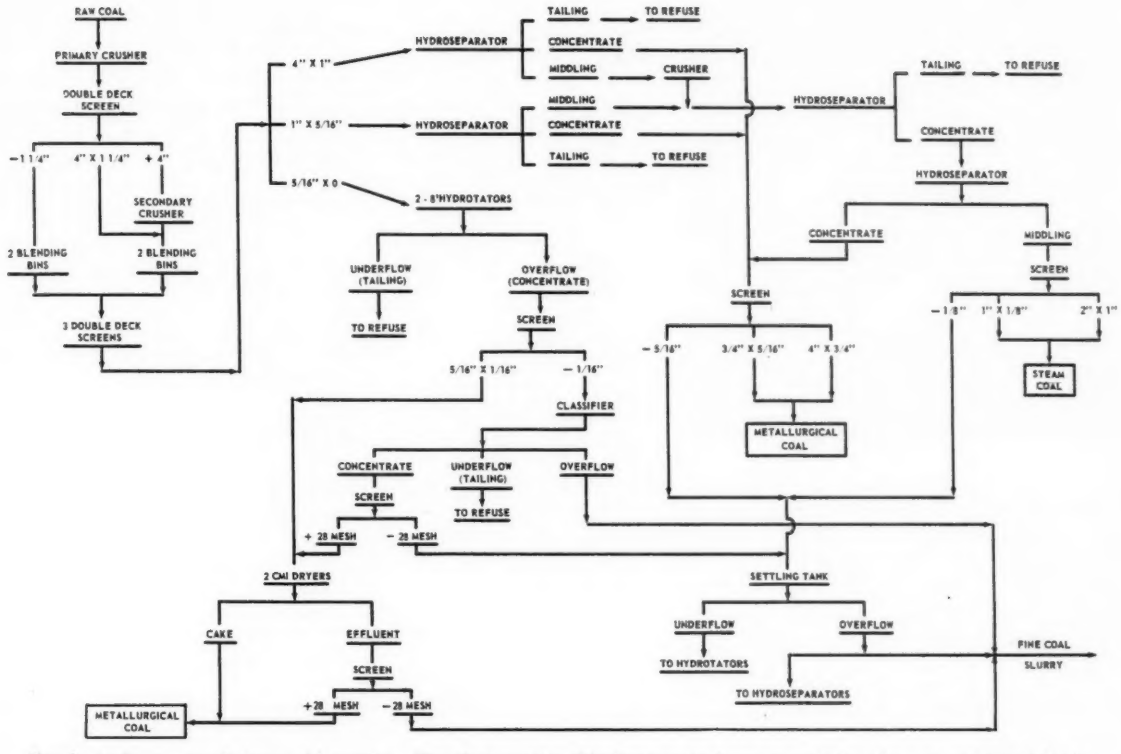
TABLE G

Comparing Filter Cake Quality

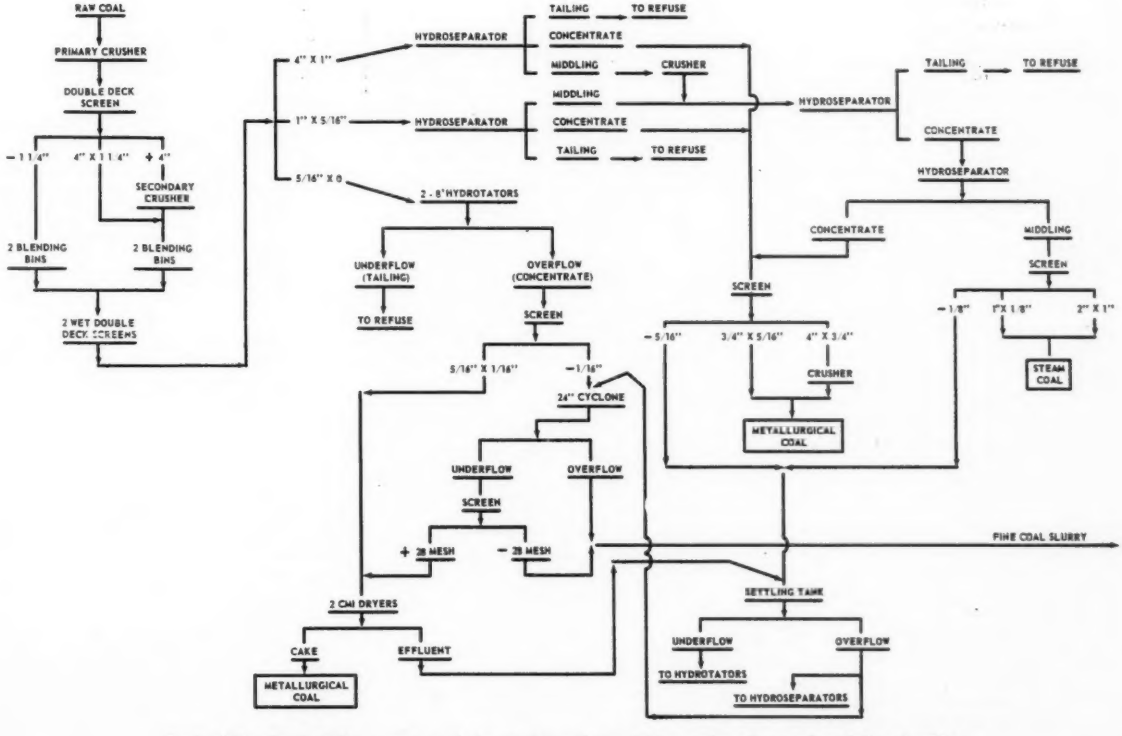
Date	Ash (%)	Sulfur (%)	Practice
January 1956	18.41		Old practice
September 1956	15.80	2.29	Cyclone and thickener in series before flotation
August 1957	8.17	2.02	After flotation



Left: fine coal circuit, old practice. Right: changes in the fine coal circuit include beneficiation of the minus 28-mesh cyclone underflows by flotation and flocculation of the thickener feed to provide clear water for recycle



Flowsheet of coarse coal circuit, old practice. The plant consists of hydroseparator boxes to wash the 4 by 1 in. and 1 by 5/16-in. coal, and hydrotator units, with a classifier concentrator, to process the minus 5/16-in. coal



Revised flowsheet of the coarse coal circuit shows that a 24-in. cyclone has replaced the classifier

Battery of three-in. cyclones. One of the changes made in the plant was arranging the cyclones and the thickener in series. The fine coal slurry was first classified through the cyclones and final overflow was discharged into the thickener

Ash and sulfur contents of the filter cake were reduced, however, the rejection of ash was more substantial than that of sulfur. The removal of the clayey material from the filter cake also improved the mixing of this product with the coarse metallurgical coal.

Over-All Product Quality, Uniformity

The improvement in the over-all quality of the metallurgical coal is shown in table H which gives the average analysis of the product during various stages of activity.

TABLE H

Comparing Product Quality

Date	Mine Coal Analysis Ash (%)	Sulfur (%)	Practice
January 1956	8.74	1.60	Old practice, filter cake to metallurgical coal
April 1956	8.07	1.61	Old practice, stocking filter cake
September 1956	8.65	1.49	New practice before flotation
August 1957	7.44	1.35	New practice after flotation

Quality of the product has been upgraded as evidenced by the lowering of ash and sulfur contents.

At Crucible's Midland Works, a barge is unloaded by means of a clamshell which dumps the coal in a hopper which in turn discharges it on a conveyor belt to the coke plant. Samples are taken periodically from this conveyor belt. Any variation in the uniformity of the product quality will therefore be reflected in Midland's daily analysis of the coal.

The improved uniformity in the product quality is demonstrated by the data shown in table I which gives the monthly average Midland ash analysis of the metallurgical coal with its calculated variant and mean deviation under various stages of washer operations.

TABLE I

Comparing Product Uniformity

Date	Midland Coal Analysis Ash (%)	Variant	Mean Deviation	Practice
Jan.'56	9.11	0.79	0.66	Old practice, filter cake to metallurgical coal
April '56	7.82	0.30	0.42	Old practice, stocking filter cake
Sept.'56	8.62	0.56	0.60	New practice, before flotation
Aug.'57	7.30	0.25	0.42	New practice, after flotation

SUMMARY AND CONCLUSIONS

To facilitate the processing of fine coal slurry and to improve the performance of the coarse coal circuit, numerous changes have been made in the plant. These changes include the wet classification of the minus ten-mesh coal by cyclones, beneficiation of the minus 28-mesh cyclone underflows by flotation, flocculation of thickener feed to provide clear water for recycle, and the disposal of the fine refuse as cake by filtering the thickener underflow.

The following results were obtained:

(1) Improvement in coarse coal washing.

(2) Improvement in filter cake quality.

(3) Reduction in steam coal production.

(4) Improvement in over-all product quality.

(5) Improvement in over-all product uniformity.

(6) Improvement in coal yield.

(7) Easy control of circulating water density and viscosity for stable operation.

(8) Complete elimination of the need for a waste pond except for emergencies.

(9) Establishment of a closed circuit operation.

The author wishes to express his thanks for the assistance given him by his colleagues in the preparation of this paper and for the permission granted him by the Crucible Steel Company of America to publish these data.

HAMILTON DISCUSSION

(Continued from page 41)

mine personnel at relatively little cost. It is significant to note that the AMC Underground Power Committee's subcommittee studying a-c power for underground mines has proposed the use of this circuit as evidenced in their preliminary report presented in Pittsburgh, November 1957.

Mr. Huffman has mentioned the availability of a-c motors on practically any type of mining equipment. It is also important to mention that the electric equipment for supplying power to a-c mining machinery is available for any type mine power system. This includes equipment for primary voltage levels up to and including 6.9 kv as well as low height mine load centers suitable for thin seam operations.

Factors to Consider When Planning an A-C System

In summary, it can be said that the following items should be considered when planning an a-c mine power system:

In consideration of voltage regulation:

a) Diversity of load in the section.
b) Maximum motor size and resulant voltage dip caused by starting of that motor.
c) Effect of capacitors and voltage regulators in minimizing voltage swings versus their relative cost.
d) Need for keeping low voltage cable circuits short.

In consideration of primary voltage level:

a) Maximum distance the power must be transmitted.
b) Maximum size load in the sections.
c) Availability of portable equipment for transmission and switch of power.
d) Relative cost of high voltage surface lines with boreholes, and the environmental conditions which may effect the maintainability of such a system versus the cost of underground transmission of power.
e) Type of haulage system used.

In consideration of system protection:

a) Resistance grounding the primary distribution system and the type of utility supply in order that resistance ground can be applied.
b) Use of a ground continuity check circuit.
c) Providing circuit protective devices whose tripping ability is not dependent upon the power system voltage level.

In consideration of reliability and flexibility:

a) Portability of power system equipment.
b) Sectionalizing of power system.
c) Distribution boxes versus mounting of the feeder circuit breakers at the mine load center.

A thorough consideration of these factors will go a long way toward planning a good a-c mine power system.

Wide range of easily controlled temperatures to 5000°F . . .no warm-up time needed . . . no sample contamination . . . allows atmosphere control . . . provides narrow heat zone . . . relatively inexpensive to build . . .

A SOLAR FURNACE for Metallurgical Research

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NOT too long ago, the Kennecott Research Center in Salt Lake City received a letter from a gentleman who wished to know what tonnage of ore could be smelted in the Center's solar furnace in an eight-hr day. Actually, scientists at the center had never figured the capacity in quite that way, but after a rough calculation they were forced to admit that a good day's effort might produce about one lb of smelted product. Other people wish to know if a prototype of the furnace could be used to heat a house or distill water. These questions are asked in all seriousness and are typical of the type of misconception that exists as to the size and application of small solar furnaces. Because of the frequency of this type of inquiry, it seems well to preface this article with a general description of a solar furnace and its applications.

Solar Radiation Concentrated by Lens or Reflectors

First of all, solar furnaces are devices for concentrating, into a much smaller area, the solar radiation striking a large area. This can be accomplished with either a lens system or with suitable reflectors.

Figure 1 illustrates how this is accomplished with a parabolic mirror. (Smoke was used in this photograph to show the converging beam). Everyone has burned wood and paper (and themselves) with a magnifying glass, and Lavoisier demonstrated that diamond was a form of carbon using a double lens furnace. Only one major solar furnace installation is presently known, however, that utilizes a lens system. This furnace is at the California Institute of Technology and consists of an array of 19 sets of double lens systems which provide a collecting area of 57 sq ft.

Because of cost and technological difficulties, all other modern furnaces utilize reflectors as concentrators. Figure 2 illustrates the most common types of mountings. The crossed arrows indicate that the mirror so marked is movable about two axes and can be used to track the sun. This tracking may be accomplished either manually or by using clockwork or photocell activated drive

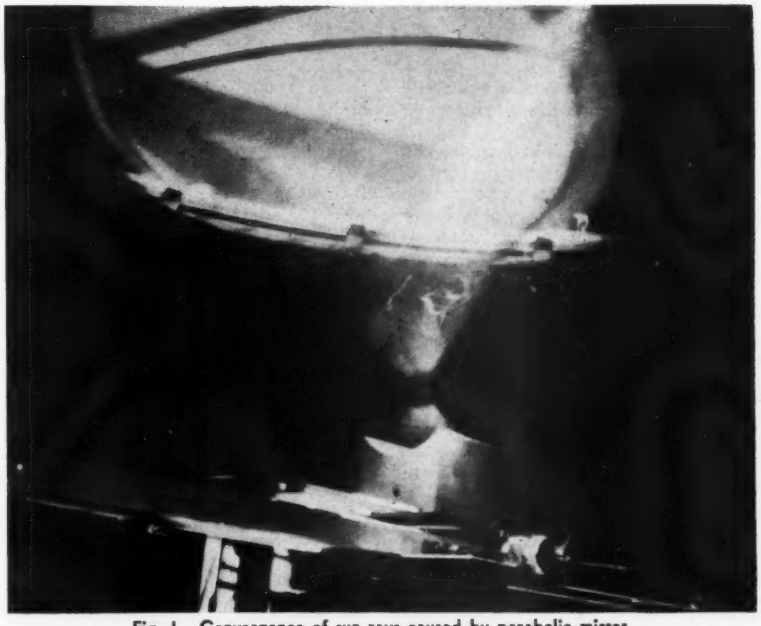


Fig. 1. Convergence of sun rays caused by parabolic mirror. Smoke was used in this photograph to show the converging beam. The dark region, immediately above the block at the point of convergence, is the heat zone

mechanisms. In the latter cases, this automatically controlled mirror is called a heliostat.

The simplest and most efficient mounting is shown in **A**. In this case the sample mounting is of secondary importance, and with only one reflecting surface, highest temperatures are possible. **B** shows a type of mounting that increases the ease of sample handling somewhat. The French have used this mounting for relatively large applications, placing the material to be melted in a rotating black body cavity. Mounting **C** allows the sample to be heated from above and is most flexible for research purposes. It requires a considerable amount of vertical clearance when the sun is high in the sky in order to avoid shading.

Size of Collector Is Greatest Problem

It has been estimated that the solar energy falling on Lake Mead daily exceeds by five times the rate that power is generated by the hydroelectric generators at Hoover dam. It is clear that the total energy striking large areas is enormous; however, when one considers building a solar furnace, he can take advantage of only that radiation reaching the collector of the furnace. This poses the greatest problem for the builder of a solar furnace. In Salt Lake City, for instance, the average solar energy received is 1442 BTU (or 0.420 kw-hr) per sq ft per day. The average heat content of bituminous coal is 13,100 BTU per lb. From these figures it is seen that all of the energy from the sun striking an area 10 ft by 10 ft in a day could be equaled by burning 11 lb of coal. Clearly the collector for a production type furnace would be immense.

Size, nevertheless, has not entirely discouraged the construction of large capacity solar furnaces. In France, Trombe and co-workers have built a 60-kw unit capable of melting up to 500 lb of steel per day, and they are building a 1000-kw unit. This latter furnace will have a concentrator 177 ft long by 131 ft high. Despite the obvious high cost of building such a unit, the French workers feel that a production type solar furnace in an area of good sunlight would compete economically with an equivalent size electric furnace located in an area having ample hydrolectric power. So far as workers in the United States are concerned, at the present time, this is an experiment that will continue to be observed with interest.

A recent survey of solar furnace installations in the United States listed 21 furnaces. The smallest furnace has a concentrator 36 in. in diameter and the largest has a concentrator 28 by 28 ft. Nineteen of these furnaces have focal spots one-half in. or less in diameter, and handle only small samples. The large

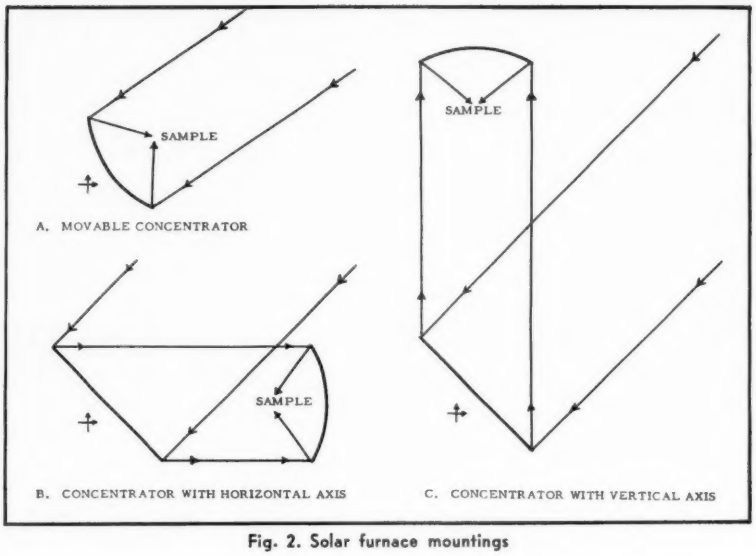


Fig. 2. Solar furnace mountings

furnace mentioned has a theoretical image diameter of four in. and has been built by the Quartermaster Corps to test the effect of thermal radiation on various materials and determine the protection offered to personnel by these materials. Solar furnaces are well adapted to this type of testing because of the possibility of flash application of intense radiation. In addition to the above-mentioned furnaces, the Air Force has recently announced its intention to build a very large furnace presumably for testing materials of construction.

Several Advantages for Research Work

It is seen from the foregoing discussion that while solar furnaces can be designed for industrial application, the greatest use at present is for research and specialized applications. Some of the features that make them attractive for research purposes are:

1. **High temperature**—equal to or greater than conventional electric arc, resistance, or induction furnaces
2. **Pure heat**—no products of combustion, contaminants from

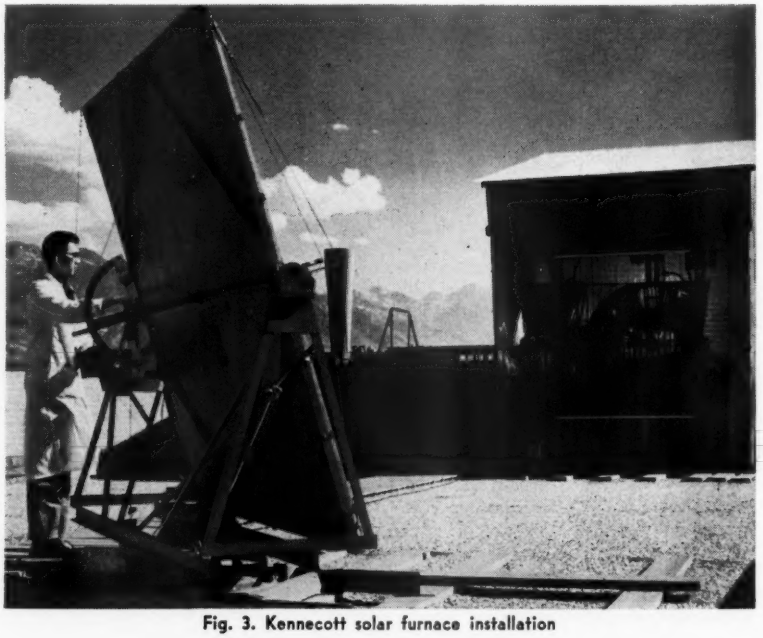


Fig. 3. Kennecott solar furnace installation

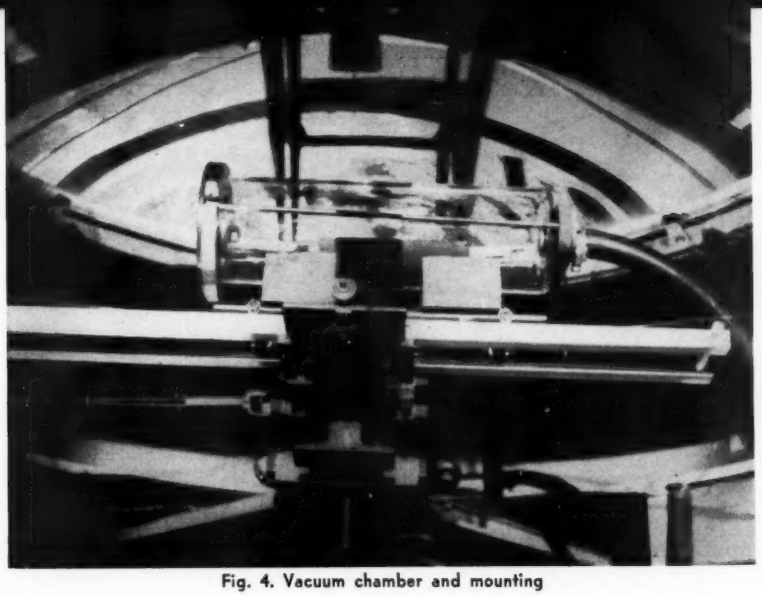


Fig. 4. Vacuum chamber and mounting

electrodes, or electromagnetic field

3. **Maximum temperature** is immediately available—no warm up time necessary

4. **Sample is heated from within**—can be used as its own container, thus avoiding contamination

5. **Sample can be heated** in a pyrex glass container. Affords atmosphere control

6. **Narrow heat zone**—desirable for zone refining experiments

7. **Wide range of temperatures**—easily controlled

It has been reported that temperatures of the order of 90,000°F can be achieved with certain laboratory devices. The fact remains that solar furnaces with comparatively lower temperatures are more favorable for most technological purposes and scientific investigations because they are not seriously limited as to continuity of operations, allow atmospheric control, and do not contaminate the sample. Some workers have reported obtaining temperatures up to 6300°F with mountings in which the parabola was directed at the sun. The Kennecott furnace with two intervening mirrors has reached over 5000°F. The maximum temperature is determined by the efficiency of reflection, the optical quality of the mirrors and the ratio of aperture to focal length. One can achieve as high or higher temperature with a small furnace as with a large one, although the area heated is proportional to the focal length of the concentrator.

The temperatures obtainable with the furnace are dependent upon the quality of sunlight available. Direct radiation is essential for the operation of a solar furnace; thus freedom from haze, whether due to natural moisture, smoke, smog, or other causes, is desirable if highest temperatures are desired. In areas near the east coast, workers have reported better results during the winter months because of a clearer atmosphere. In the Salt Lake area, however, smoke and haze restrict winter operation. In this region, good conditions for operation are to be expected from March through October. Excessively windy conditions also have a bearing on operation because of instability of the heliostat and consequent shifting of the focal spot.

Kennecott Furnace Described

In the spring of 1955, it was decided to activate the development of a solar furnace at the Center as a part of the research program which Kennecott assigns to fundamental studies. In addition to the fundamental value of such a development, there was a growing need for a high temperature furnace for our research. The effects of various furnace atmospheres on smelting procedures and results were of particular interest. Specialized techniques such as vacuum fusion and zone refining were becoming increasingly more important in research and in the production of high purity metals. Molybdenum, rhenium, and niobium are examples of important metals that required special purification and fabrication techniques because of their high melting temperatures and affinity for gases such as oxygen and nitrogen. All of these factors pointed to the necessity for a versatile unit, and when it was found that a solar furnace that would handle this type of research could be constructed at a very moderate cost, the company decided to build one.

In many respects the Kennecott solar furnace is similar to other small furnaces mentioned above. In order to attain the most flexible arrangement for sample handling, however, the parabolic mirror was mounted on a vertical axis with a fixed flat mirror below it at a 45 degree angle for redirecting the rays from the movable mirror into the parabola. The installation is shown in figure 3. The movable mirror or heliostat directs the sun's rays to the mirror under the parabola; from there the rays pass to the parabola and are then focused on the sample. The movement of the heliostat is controlled by photocells at the periphery of the parabolic mirror. The vertical blind is used for temperature control. Because it was possible to use a war surplus searchlight, which was obtained at scrap price, as the basic unit in construction of the furnace, the initial cost of the installation was low—about $3400. This includes construction and labor costs but is exclusive of research time. Recent modifications have increased this expenditure somewhat but it is felt that a second unit could still be built within such a budget.

Worthwhile Addition to Laboratory Equipment

Metals, at high temperatures, are very susceptible to oxidation. Dissolved gases also affect their physical properties very much. On the other hand, ceramic materials generally require oxidizing conditions for their fusion. Because of the flexibility of atmospheric control, the solar furnace can easily handle all of these problems. Figure 4 shows the sample container used for high vacuum and controlled atmosphere work. It is constructed of pyrex glass and is four in. in diameter. Inasmuch as the glass wall is out of focus, it does not get overheated even though the sample temperature may approach 4500°F.

The greatest emphasis, thus far, has been on vacuum fusion studies. Niobium sponge, melting point about 4500°F, treated in this furnace has yielded a malleable product in a relatively short time. Presently attempts are being made to develop a technique which may lead to greater precision in the difficult problem of determining the gas contents of metals.

Sufficient preliminary zone refining studies have been completed to illustrate the high potential of the furnace for this technique.

This relatively inexpensive furnace has proved very useful in high temperature testing of small samples and is a very worthwhile addition to our laboratory equipment. Future experiments will determine whether the company will be justified in providing a searchlight as an auxiliary source of heat. In this case the temperatures attainable would be dependent upon the temperature of the arc used. Such a source would permit year-around operation independent of weather.

Ventilation Problems In Connection With Continuous Mining Machines

"What is the best method for conducting air to the face and providing uninterrupted and adequate quantities of air to dilute liberated methane, assure enough velocity to sweep across the face, and at the same time be economical, be easy to maintain, not handicap production, or create excessive dust?"

By D. S. KINGERY
Chief, Mine Ventilation Section
Branch of Health Research
Division of Health, U. S. Bureau of Mines

THE introduction of continuous mining machines into gaseous coal mines has concentrated, in a single rapidly advancing coal face, the problems normally encountered in conventional mechanized mining. With conventional mining, much of the occluded methane confined to the cubic dimensions of the prepared face is released simultaneously when the coal is shot. Provided the face ventilation is adequate, only small quantities of trapped methane plus the gas bleeding from the face and rib fissures remain by the time the loading machine enters. In continuous mining, on the other hand, the methane is released at a steady rate as the mining machine advances. This rate is small compared with the relatively large slug released by blasting, but it nevertheless constitutes a more difficult ventilating problem.

With continuous mining and a steady rate of gas emission, control of air at the face must be reliable, since even a slight interruption in ventilation may permit methane to build up in front of the machine. If the mine is operated in a safe manner, a production stop is necessary until the methane can be cleared. Also, with continuous mining machines, the problem of conducting air from the last breakthrough to the face with line brattice is ordinarily more difficult. Both boring- and ripper-type machines restrict side and overhead clearance by their size and operation; consequently, in many instances only a very small quantity of ventilating air—most of it induced through convection by heat from the

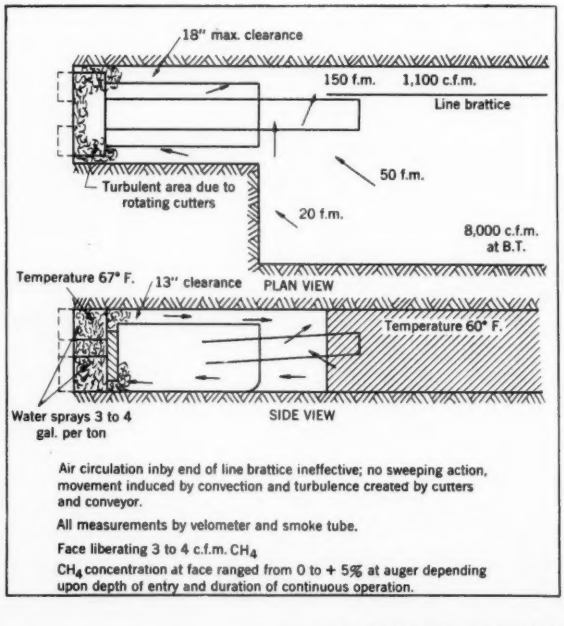


Fig. 1. Continuous mining machine ventilated by means of exhaust-type brattice

machine—actually reaches the face. When a boring type machine with the face shielded by the front of the unit is used, the methane released is concentrated in advance of it. Such conditions require a high-velocity air sweep across the front of the unit to dilute gas liberated by the augers and released around the machine head and through the conveyor port.

Potential sources of ignition, known to have caused several face ignitions, are the sparks from auger bits striking hard foreign material in the coal bed.

Another ventilation consideration often overlooked with continuous mining machine operations is that, after the machine advances, the ribs outby will continue to liberate methane at a greater rate and for a longer time than when coal is prepared and shot, because blasting slightly fractures the surrounding strata, permitting easy release of occluded methane. The time lapse between the usual cutting, shooting, and loading cycle gives the methane an opportunity to drain from the coal ribs.

The dust problem is similar to the ventilation problem; unless the tiny particles are allayed during mining or are collected by some means, clouds of dust are thrown into suspension, reducing visibility and creating an undesirable working environment. The coal dust created and the rapid advance of the machine also complicate the problem of maintaining adequate rock dusting.

The problem of face ventilation and dust control for continuous mining machines therefore resolves into: "What is the best method for conducting air to the face and providing uninterrupted and adequate quantities of air to dilute liberated methane, assure enough velocity to sweep across the face, and at the same time be economical, be easy to maintain, not handicap production, or create excessive dust?"

This is the problem. Of course, the best method at one mine may not be the best at another, and each situation presents special problems that many progressive companies have been endeavoring to solve.

Review of Current Methods

The following ventilating methods and conditions were selected as representative; they are not the worst or the best that have been studied. They do illustrate, however, the varying degree of effectiveness among methods.

LINE BRATTICE

The studies shown by figures 1 and 2 were made of a fixed-head, continuous mining machine operating in coal averaging 45 in. thick. The mine is classed as gassy, and calculations showed that the face liberated three to four cfm of methane during operations. Figure 3 shows the results of tests made at a test set-up in the Pittsburgh coal bed.

D. S. Kingery was graduated from Ohio State University in 1933. Since then he has worked as a mining engineer and geologist, and has held supervisory capacities in both coal and noncoal mining industries. During World War II he served as chief, Mining Division, Allied Military Government, for Italy, Sicily and Sardinia, with responsibility for the rehabilitation of indigenous mineral resources needed to assist the war effort. With the U. S. Bureau of Mines, he has served as mining engineer; Federal coal mine inspector; chief, Haulage Safety Section, and chief, Mine Ventilation Section.

Figure 1 shows ventilation by using an exhaust-type line brattice, with the continuous mining machine advanced into a sump cut. The line brattice extended less than 50 ft and was maintained to inby the conveyor end of the machine. Approximately 8000 cfm of fresh air was available at the last breakthrough, and approximately 1100 cfm was measured at the intake end of the exhaust brattice. Water sprays were used to allay dust during mining; however, considerable dust was in suspension, and visibility in front of the machine was poor. Safety practices required regular tests for gas. When methane was detected over the machine, it was stopped and pulled back, line brattice was extended, and the methane was removed.

The velocity measurements shown were made by velometer and smoke tubes; very little air actually reached the front of the continuous mining machine. Air movement ahead of the operator was induced chiefly by rotation of the cutting arms and by convection currents created by the heat of the machine.

Figure 2 shows ventilation using a blow brattice, with the continuous mining machine working in a breakthrough. The line brattice extended over 60 ft and 1500 to 1000 cfm of air was discharged alongside the conveyor of the machine. Velometer measurements of air velocity showed that, as the machine advanced into the breakthrough, less air reached the coal face.

In both these studies it was evident that, as the continuous mining machine advanced, the air currents were not strong enough to sweep across the front of the machine adequately. Virtually the only air conveyed to the front of the unit was due to convection caused by the heated air over the machine. The rotating cutters and the movement of the conveyor were responsible for creating turbulence at the coal face, which aided movement of air. With these line-brattice setups it was common for methane over the machine to build up to four percent and more, necessitating production stops until the face could be cleared.

The obvious question is: How effective is line brattice for ventilating continuous mining machines when large quantities of methane are released?

Figure 3 shows the air-flow pat-

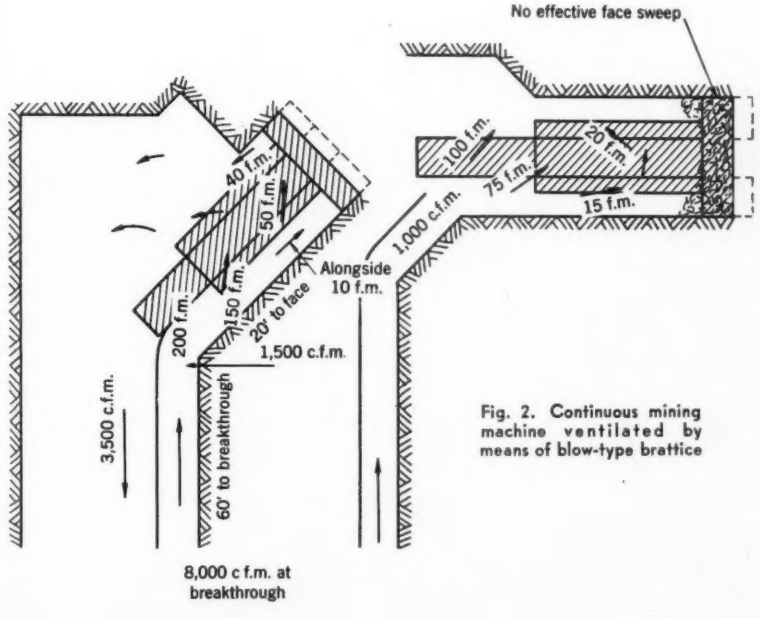


Fig. 2. Continuous mining machine ventilated by means of blow-type brattice

tern and the effectiveness of a blowing-type line brattice used with a simulated continuous mining machine advancing straight ahead and with face liberations of methane to 17 cfm.

These tests show that, with the line brattice discharging 2500 cfm at a velocity of approximately 185 fpm, the velocity dropoff was sharp, and at the face 20 ft in advance of the line brattice velocity averaged only 20 fpm.

This figure also shows the average methane percentages measured over the continuous mining machine in advance of the line brattice for face methane liberations to 17 cfm. The graph indicates that enormous quantities of air are required in effective ventilation of a face liberating more than seven cfm of methane. Subsequent tests showed that over 5000 cfm of intake air was required to ventilate a face liberating approximately 15 cfm of methane and to keep methane percentages within safe limits.

Effective ventilation by line brattice in ultragassy mines therefore is difficult; large quantities of air are required, the brattice must be installed with minimum leakage, it must be maintained close to the face, and interruptions from haulage sources or other reasons can cause dangerous methane concentrations to develop.

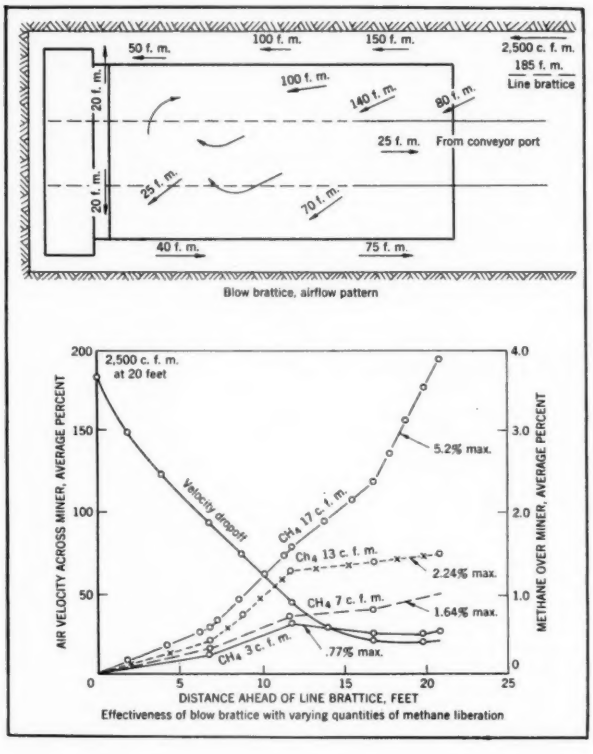


Fig. 3. Blow brattice airflow pattern and methane concentration for various quantities of methane liberation

EXHAUST FAN

Several companies have endeavored to solve both the face-ventilation and dust-control problems of continuous mining machine operation by using auxiliary ventilation with exhaust tubing. Figure 4 shows the results of a study believed representative of several installations or tests.

With exhaust tubing the negative pressure at the inlet will vary with the size and length of tubing, the amount of leakage between the fan and tubing end, and, of course, the fan pressure. Consequently, the zone of influence beyond the tubing inlet will vary with different installations, the condition of the tubing, and the length of the tubing.

This study showed the effectiveness of an auxiliary exhaust system operating in conjunction with a ripper-type machine in the Pittsburgh coal bed. The fan was axial-flow type, ten hp, operating at over six in. of water pressure and discharging 6500 cfm of return air against the resistance of 160 ft of 22-in. tubing.

The exhaust tubing, which could be extended in ten-ft lengths, was rubberized fabric reinforced with steel hoops and had an effective diameter of approximately 20 in. The tubing in service at the time of this study was suspended from spads or roof bolts along the left rib. The quantities of air returning through the tubing, as well as the quantities of intake air, were as shown in figure 4. Although the tubing connections appeared to be tight, the air leakage measured between the fan and intake was 3000 cfm.

Face ventilation at the time of this study—while adequate for slightly gassy operations—was not considered adequate for a face liberating large quantities of methane, because intake air was immediately drawn to the tubing without providing an effective face sweep. Consequently, there was virtually no air movement at either the right or left face corners; also, the center of the face for five ft outby was poorly ventilated—the only air movement appeared to be caused by convection currents. Water sprays, combined with the exhaust system,

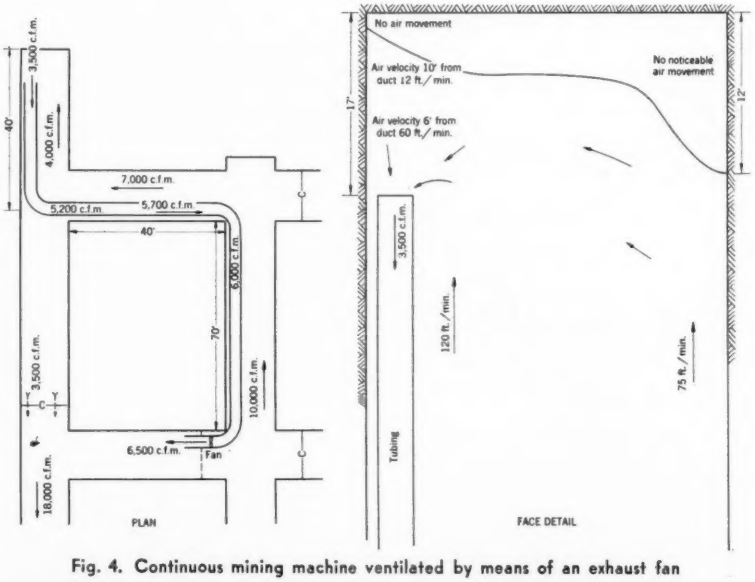


Fig. 4. Continuous mining machine ventilated by means of an exhaust fan

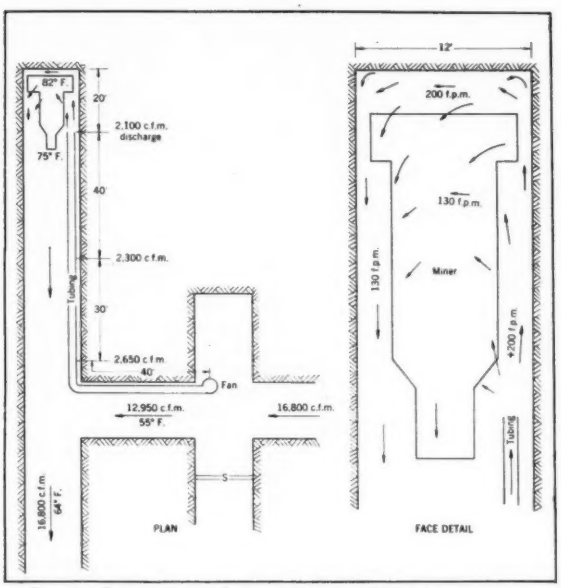


Fig. 5. Continuous mining machine ventilated by means of a blowing fan

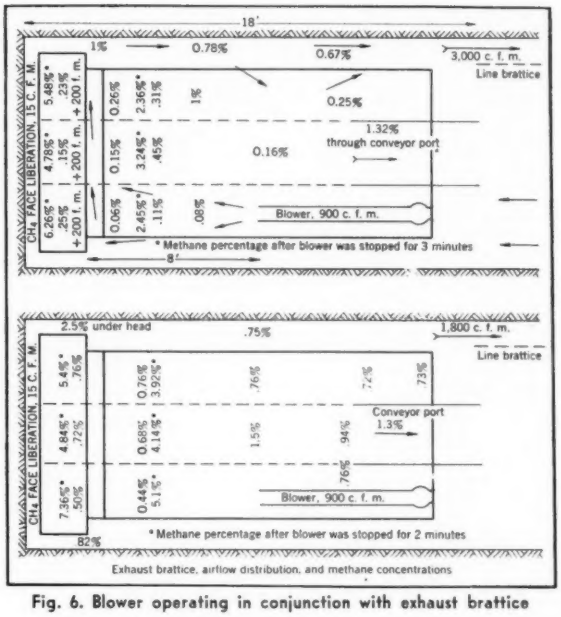


Fig. 6. Blower operating in conjunction with exhaust brattice

were reducing the quantities of coal dust thrown into suspension, and visibility thus was good. Common to all the auxiliary exhaust systems studied, the coal dust blown into the return airways created a special clean-up and rockdusting problem.

BLOWING FAN

The installation in figure 5 was used to ventilate an area in which a boring-type machine was operating in an Illinois coal bed.

The data shown represent conditions at the time of the study. Air measurements in the tubing were made with a pitot tube; measurements in the entries and face areas were made by anemometer, smoke tube, or velometer.

Ventilation was produced by auxiliary fans blowing air through tub-

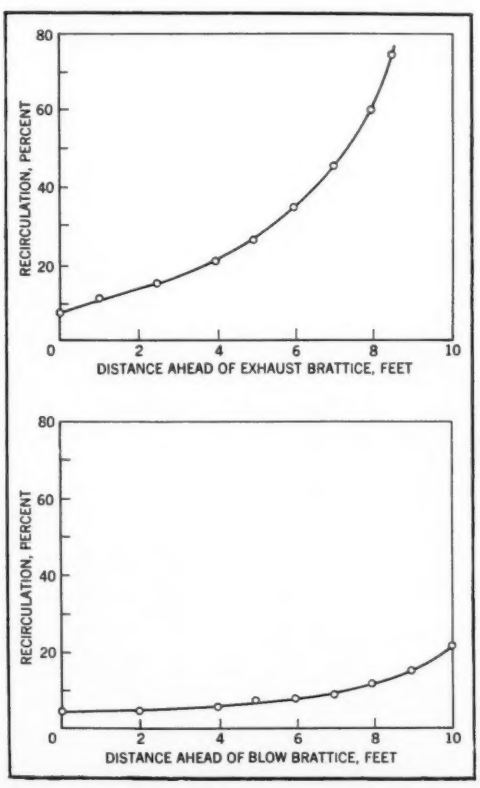
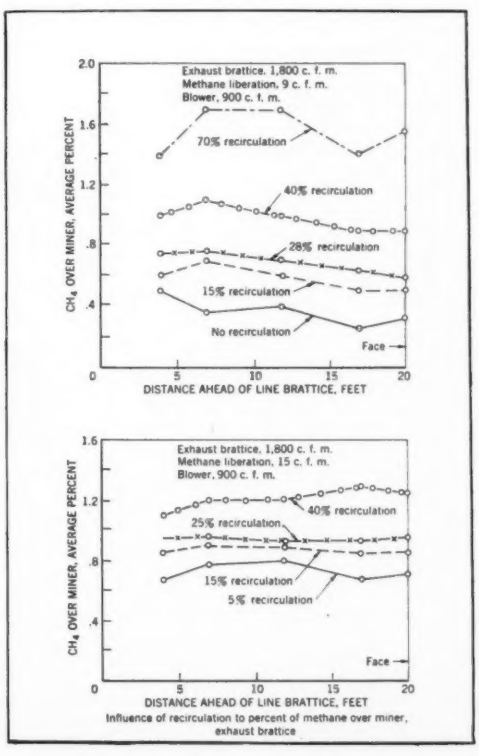


Fig. 7. (Left) Blower recirculation curves for exhaust and blow-type brattice

Fig. 8. (Right) Influence of recirculation to the percent of methane over the continuous mining machine



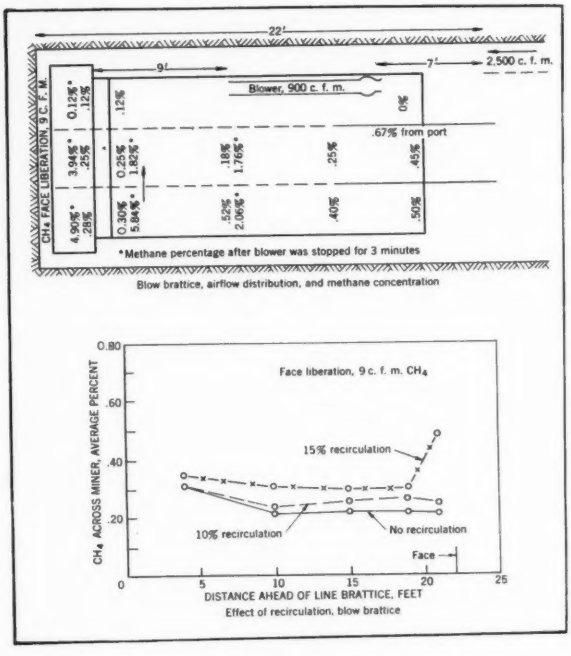


Fig. 9. Blower operating in conjunction with blow brattice

ing to the face. The first stage was to advance 300 ft, establish a breakthrough for return air, and then advance the fan. The fan was relocated approximately 30 ft outby the breakthrough, the room then was advanced an additional 300 ft, and a crosscut for return air was established near the face. This system of ventilation eliminated the need for breakthroughs at intervals of less than 300 ft.

The centrifugal fan used had 16-in.-diameter forward-curved blades and a 12-in. discharge. It operated at 1750 rpm and used a five-hp motor. The rated capacity was 4150 cfm at free discharge. The fan was operating at over seven in. of water pressure and was discharging 2100 cfm against a resistance created by 110 ft of tubing.

The blower tubing was rubberized fabric reinforced with spiral wire and was suspended from spads in the roof near the right rib. The tubing diameter was 12 in., but the accordion-type construction reduced the effective diameter to approximately 11½ in. Tubing sections were extensible from approximately 5 ft compressed to 25 ft extended. The weight of one section of tubing was such that one man could easily carry and install it.

Quantities of air flowing through the tubing, as well as the intake and return air from the setup, were as shown in figure 5. The tubing was tight at joints, and few leaks were detected. The air leakage measured 1500 cfm. These leaks were not considered excessive; ample velocity to sweep the face was measured at the discharge.

Face ventilation was considered good. Air velocities near the face ranged from 130 to more than 200 fpm. Smoke-tube tests showed a definite sweep across the front of the continuous mining machine, clearing both corners of the roof, face, and rib. The air currents at the face also were influenced by the rotating arms of the machine and by the cooling fans installed to ventilate its drive motors. These created air turbulence that assisted air movement at the difficult-to-ventilate areas in front of and under the head of the machine.

Air-velocity measurements showed that the high-velocity discharge of the tubing carried over 30 ft and registered velocities of 130 to 200 fpm. The most effective setup observed was with the tubing 20 ft from the face. This provided an excellent high-velocity sweep across the face and over the front end of the continuous mining machine.

The continuous mining machine was developing considerable heat. With intake temperatures of 55° F, temperatures of the air ranged from 85° over the front of the machine to 75° F just outby it. This heat caused convection currents that also contributed to air movement in the face areas.

Visibility at the face was adequate; it was possible in most instances to observe the cutting arms operating from the outby end of the machine. Water sprays reduced the amount of suspended coal dust, but considerable float dust still was evident.

The mine was classed as gassy, but methane was not detected during this study, and the face liberation of methane in cubic feet per minute was not determined.

Machine-Mounted Blower in Conjunction With Other Methods

The Mine Ventilation Section, Federal Bureau of Mines, decided to test the application of a small blower fan, to be considered an integral part of the continuous mining machine. The idea of such a fan, possibly operated by hydraulic takeoff from the mining machine, has been advanced from several different sources.

To conduct the necessary tests a single entry of the Branch of Health Research experimental coal mine was prepared. This mine is in the Pittsburgh coal bed and is near Bruceton, Pa. The face was cut and a network of perforated pipes was installed to assure uniform release of methane across the face area. Methane was piped to the face from Pittsburgh natural-gas supply lines. A rotometer and valve installed in the system permitted release of methane at the face for any desired quantity up to 30 cfm. The next step was to build a wooden "mockup" of a fixed-head-type continuous mining machine at the face. This mockup, while not an exact scale model of any standard machine, was made to conform with average side and overhead clearances and to have the head shield the face.

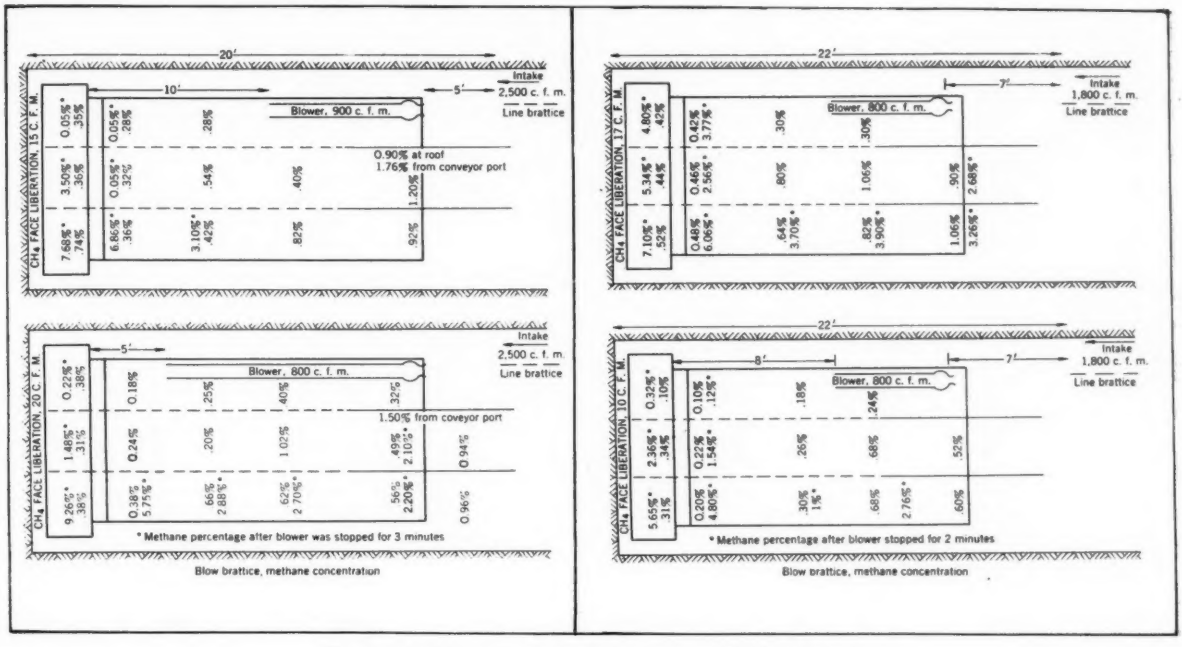
The blower was a small, variable-speed, air-driven fan discharging through an eight-in. sheet-metal duct. The static pressure of this blower was approximately 1.5 in., and it was capable of discharging air at velocities to 3000 fpm. The amount of compressed air released during operations was very small and did not influence the ventilation tests.

To assure test data that would be practicable, it was decided to work with relatively large quantities of methane and hold the intake air to the minimum safe quantities thought necessary to dilute the methane released at the face. Such tests should show if the small blower, as a fixed part of a continuous mining machine, could be integrated into the ventilation system and should also point out limitations and potential hazards.

The following show the results of certain of these tests. All test data will be incorporated in a subsequent Bureau of Mines report of investigations to be released this year. Methane determinations were made with approved-type methane testers, which were checked occasionally by analysis of vacuum-bottle air samples. Velocities were measured with velometers and air quantities by anemometers and pitot tubes.

WITH EXHAUST BRATTICE

Figure 6 shows the methane percentages determined over the continu-



Figs. 10-11. Blower operating in conjunction with blow brattice

ous mining machine, with intake air quantities to the exhaust brattice of 3000 and 1800 cfm. The liberation of methane at the face was set at approximately 15 cfm and the end of the line brattice was 18 ft from the face.

The blower was operated at 900 cfm and directed air against the continuous mining machine head at velocities exceeding 200 fpm. The methane determinations over the machine, except one reading of 1.5 percent midway over the machine at the roof, showed excellent air-methane diffusion. The highest consistent methane percentages were 1.32 emanating from the machine conveyor port and 2.5 percent from under the head alongside of the machine. With the blower stopped for three minutes the methane over the front of the machine increased to the lower explosive limits.

The blower in these tests kept the face clear, and the entrainment ratio for the blower was measured to be approximately four; consequently, over 4000 cfm of air at high velocity was sweeping over the continuous mining machine. The entrained air was not all intake air; most of it was air that had swept the face and was reentrained by the jet discharge of the blower. This condition is common to all jets or high-velocity air streams and provides a mechanical advantage in that more air is available for face ventilation than passes through the fan. The amount of methane in the entrained air contributes to the methane percentages over the continuous mining machine. However, as equilibrium is reached, that is, the return air passing through the line brattice contains the same quantity of methane that is released at the face, the methane content of any reentrained air is constant, and, unless the volume of intake air is inadequate, it does not appreciably change the methane content of the air.

The greatest hazard with a blower operating with exhaust brattice is recirculation in conjunction with air entrainment. As the continuous mining machine advances, the blower advances ahead of the line brattice, which, of course, becomes farther back from the face. The velocity of the incoming air is too small to carry far; this in effect reduces the amount of intake air available for ventilation. Consequently, the blower draws air returning from the face through the fan,

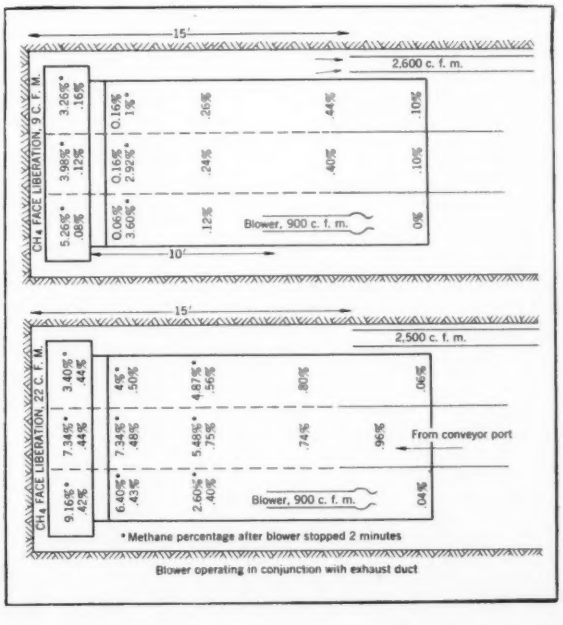


Fig. 12. Blower operating in conjunction with auxiliary exhaust duct

a condition that reduces the intake air handled by the fan, adds methane to the face area, and (in conjuction with reduced intake-air quantities) increases the methane content of entrained air. The percentage of return air or recirculation will depend how far in advance of the line brattice the blower operates.

Figure 7 shows the recirculation curve for both exhaust- and blow-type brattices. The exhaust curve shows that, when the blower is approximately eight ft ahead of the line brattice and the line brattice 26 ft from the face, recirculation was measured at 60 percent. The influence of recirculation on the percentage of methane over the continuous mining machine is shown by Figure 8. These charts show the average methane percentages over the machine and the influence of recirculation. Both charts are for an exhaust brattice starting at 17 ft from the face handling 1800 cfm of intake air and with the blower discharging 900 cfm. With a face liberating nine cfm methane, 40-percent recirculation is maintained about one percent over the machine, while with a methane liberation of 15 cfm, 40-percent recirculation increased the methane percentage over the machine to substantially over one percent.

The amount of suspended dust with this ventilating plan is not desirable. The entrainment caused by the blower picks up dust from the top of the continuous mining machine, ribs, and roof. Without very efficient sprays to allay dust at the source, visibility is poor; another disadvantage is that, unless the machine operator works opposite from the line brattice he will be surrounded by dust-laden return air.

Briefly summarizing these tests, it is evident that use of a blower in conjunction with exhaust brattice presents a problem with regard to recirculation, which necessitates maintaining the line brattice close to the continuous mining machine. Also, any interruption of ventilation could cause hazardous conditions to develop. This type of ventilating plan probably will not be suitable for other than slightly gassy operations.

WITH BLOW BRATTICE

Figures 9, 10, and 11 show the percentages of methane measured over the continuous mining machine with intake-air quantities of 2500 and 1800 cfm. The liberations of methane used during the tests ranged from 9 to 22 cfm.

These tests show the effectiveness of the blower, which actually diffused the air over the machine and prevented high concentrations of methane from developing.

Effectiveness of the blower is shown by the fact that, when it was shut off for two minutes, dangerous percentages of methane immediately built up over the continuous mining machine.

The problem of recirculation was not as great with a blowing brattice as with an exhaust brattice, since greater air velocity exists, which if directed at the fan intake reduces the percentage of return air handled by the blower. The hazard of recirculation is present, however, and necessitates that if the blower is to effectively reduce methane concentration the line brattice should be maintained within 10 to 12 ft of the blower.

The mechanical advantage of entrained air exists, as with exhaust brattice; approximately 4000 cfm of high-velocity air currents were sweeping across the continuous mining machine head and the area in front of the fan discharge.

Problems of dust control again are difficult since the entrained air picks up dust particles, throws them into suspension, and they are carried back over the machine. Effective sprays help; but, even with good dust-allaying sprays, visibility is likely to be poor.

A brief summary of this method is that it appears to be much better than exhaust brattice systems. In all tests the face was effectively ventilated whenever the line brattice was maintained reasonably close to the blower. Enough intake air should be available to dilute face liberations of methane to 0.5 percent. That is, a face liberating ten cfm of methane should have a minimum of 2000 cfm of uninterrupted intake air discharging from the line brattice; if the air intaking contains any methane, more than 2000 cfm should be used.

AUXILIARY EXHAUST DUCT

Figure 12 shows the methane percentages measured over the continuous mining machine with intake-air quantities of approximately 2500 cfm. The methane liberations used during the tests ranged from 9 to 22 cfm. The end of the exhaust duct was 15 ft back from the face.

These tests also show the effectiveness of the blower as a diffuser; with the blower operating, methane percentages over the continuous mining machine were within safe limits. With the blower stopped, methane immediately built up to within the explosive range.

The problem of recirculation was similar to that with the exhaust brattice; unless the end of the exhaust tubing or duct is maintained ahead of or equal to the intake end of the blower, recirculation develops. The advantage of exhaust tubing is that it is easy to extend by suspending it from the roof. It can also be attached to the continuous mining machine with flexible spiral tubing which assures that it will always be ahead of the blower. In many respects ventilation tubing is superior to line brattice, since it is easy to extend in short sections, can be suspended without obstructing haulage operations, and will not leak as much as line brattice. However, exhaust tubing must be kept close to the face to be effective, and without the aid of the small blower to carry air to the face does not provide adequate ventilation except in slightly gassy faces.

Problems of airborne dust can be greatly reduced by utilizing exhaust tubing in conjunction with the small blower. The small blower will cause dust entrainment as in the other tests; however, if the end of the exhaust tube is maintained ahead of the machine operator, virtually all of the airborne dust will be picked up inby his station. Provided sprays are used to allay dust during operations, visibility to the head of the machine will be relatively good.

Conclusions

Based upon the tests completed the small blower mounted on the continuous mining machine appears very promising. Complete engineering data are not available to date; however, these preliminary data indicate that the blower provides the added velocity necessary for effective face ventilation under gassy conditions. Of the tests made to date, the most promising from both ventilation and dust control appears to be the blower in conjunction with an auxiliary exhaust system, with the tube end maintained close to the face. This arrangement appears to be the best solution for the dust problem, and if enough intake air is provided it can be made to ventilate most coal mine faces effectively.

The blower operating in conjunction with exhaust brattice presents a problem of recirculation, with associated potential hazards. It is difficult to maintain tight line brattice close behind the continuous mining machine in concentrated working areas; consequently, this plan will give more trouble than blowing brattice, which does not need to be maintained as close.

The blower operating in conjunction with blowing brattice, while suitable for face ventilation, provided the line brattice is maintained properly, is not good from the dust control requirement.

To reiterate, all these tests indicate that a small blower within the range of 700 to 1000 cfm could be a valuable adjunct to face ventilation; however, the blower must not be depended upon to do the job alone. Enough intake air must be provided to dilute the literated methane to safe limits.

Many other tests have been conducted, and more are planned; after these data have been analyzed, definite information will be available concerning the application of a small blower as an adjunct to face ventilation of continuous mining machines operating in both high and low coal beds.

Production, administrative and marketing problems of the complex minerals industry require competent executives who need not be exceptionally talented, but who know how to use whatever ability they have—effectively

Selection And Training Of Prospective Executives

The best basis for selection of a prospective executive—a number of appraisals from people who have been exposed to him in superior, subordinate and equal positions. The most essential part of a training program —an atmosphere conducive to executive development

By JOHN G. NEUKOM
Director, McKinsey & Company, Inc.

THERE is a fairly constant chant for executives of ability throughout American industry, and it is heard as loudly in the mining industry as anywhere. There are those who insist that the need for competent executive talent grows more acute almost each passing year, and they quote statistics which show that the number of executive positions have grown proportionately with greater rapidity than has the total work force. The Department of Labor tells us that in the next ten years our work force will increase 15 percent. During the same period, the number of proprietary and managerial positions will increase approximately 22 percent.

Other students of the subject in their search for the reasons for this condition point to the delayed effect of the reduction in the identification of managerial talent during the depression of the 30's, the interruption of World War II in many managerial careers, the influence of more rigid retirement programs, and the increasing complexity of modern management. All of these points appear to have merit, but the author must add that in his own experience a rather loud cry for competent management has been clearly audible as a part of his earlier memories and professional career dating from 1934. Many of McKinsey & Company's client companies badly needed and were actively looking for more talented top management in those difficult days just as many are today. The company has never known the time when any large number of its clients were without need of additional management talent.

Consequently, the increase in need can not be accurately measured, but whether or not it has grown relatively in recent years its recognition most certainly has, and along with this recognition as a parallel has grown the willingness and desire of many managements to undertake to do something constructive and aggressive to meet that need. Hence the light of inquiry shines brightly on this subject of developing managerial talent in management conferences all over the country.

It is clear from the title that this is a two-step discussion—the first part having to do with identifying the individuals that seem to be prospective executives and the second part having to do with the activities or undertakings that are likely to be helpful in developing these candidates to their full potential.

Criteria for Identifying Executive Talent

In order to identify prospective executives it is necessary to agree on what you are looking for, and there seems to be growing agreement in management circles with regard to the talents that are found repeatedly among competent executives, and therefore, that should probably be looked for among the prospective executives.

For example, at a recent General Management Conference of the American Management Association, five chief executives spent an afternoon identifying the qualities of the ideal manager and came to a general agreement that he should have "good physical and mental health, reliability, open-mindedness, flexibility, understanding of human behavior, ability to plan, the desire to participate, a willingness to accept responsibility, and a willingness to make personal sacrifice."

Dr. G. L. Bach, Dean of the Graduate School of Industrial Administration at Carnegie Institute of Technology, in noting that you don't identify good executives by physical characteristics but rather by below-the-surface qualities specifies these:

1. Orderly ability to size up problems and reach action decisions on the best facts available

2. Ability to deal effectively with people and to get people to work effectively toward a common goal

3. Instinctive acceptance of responsibility

4. Thorough understanding of the interrelations between his business and the economic, social and political forces of the entire environment.

5. Imagination to sense what is fundamental in the rapid change of modern industry and modern society. (No human trait is more common than to do what seems comfortable, accustomed and secure. The executive who tries to keep on building buggies in the air age, or who insists, "the way I learned to do it is the best way," is commoner than many of us like to admit.)

McKinsey works closely with client top managements. The author has been able to see them intimately as they deal with problems of a wide variety of sizes and types. On this basis his experience suggests that the following characteristics are those that you should look for in prospective executives because they are the ones that seem to be most important in successful executives:

1. Energy, enthusiasm, and drive: This bundle of traits seems to have its foundation in good health. The selection process for executive material should include a health examination. Many progressive companies today require thorough annual physical examinations for all executives.

2. Good mental equipment: A few outstanding executives are brilliant; many have better than average minds, but most have only good minds—which they have learned to use effectively. The mind can be trained just as any other physical asset. Of course, training the mind is the first objective of competent higher education. The most important reason for requiring a candidate to have a degree from a good school is because that condition increases the probability that you are hiring a trained mind.

3. Reliable judgment: After the facts are in and the research is completed, many executive decisions must be based on a sense or a feel of the situation and an understanding of the circumstances. Here reliability of judgment is invaluable. It is an additionally important characteristic because a candidate with reliable judgment will have increasing confidence in that judgment as it serves him well. Then he is willing to make his decisions more promptly and with greater determination. This is important, because the most common complaint with regard to the inadequate executive is the lack of his decisiveness and unwillingness to make and abide by his decisions. As one banker friend has said, "I've known a number of successful business careers based on a series of decisions, many of which were bad, but I've never known a successful career based on indecision."

4. Imagination: Executives must get ideas. Like mental equipment, most successful executives have good—but not outstanding — imaginations which they have learned to use well—and often.

5. Sense of humor: The greater the executive, the less likely he is to take himself too seriously. That does not mean he is not serious. But he has a lightness of touch and an informality of manner that seem to have their origin in a sense of humor. A sense of humor can be developed, but there must be a start of it, at least, in the man's nature.

6. Attractiveness to others: There are no particular standards of appearance in outstanding executives. Nor do they necessarily have what might be called a "fine personality." Certainly, a fine appearance and personality contribute to executive success. But all that is essential is a personal make-up that gives the man a reasonable degree of "attractiveness to others." The essential requirement is that others enjoy their association with the man.

7. Emotional stability: This is one of those abstractions that is not very meaningful to most executives. But it is a useful label for a phase of personal make-up that has to do with the maturity, stability, and solidarity of emotions to keep the individual from "going to pieces" when he is under pressure. The emotionally stable person does not get unduly upset when the "going is rough" and there are many important things to do at the same time. Like a sense of humor, emotional stability can be developed if its foundations are there.

In addition to these general characteristics, of course there may be some special requirements for any given job, physical, mental, or technical knowledge that should be added to the characteristics that we seek to identify. There may be a reason why your candidates need engineering degrees, or foreign languages, or the ability to understand the viewpoint of people who spend large parts of their lives underground.

Selection of Individual Candidates

However, once you have agreed on the characteristics that are needed among your prospective executives, how do you go about determining whether they exist in the case of individual candidates? Many techniques are used, and there is a constant search for any easy way. The president of one important company reported that he searched for his candidates by wandering through the offices after 5:15 to see who had enough interest and energy to constantly work overtime. This technique

ultimately failed, because he found that in this group he not only had the enthusiastic and energetic but also a lot of candidates who were just simply slow in getting their work done. Then he also found that in short order the technique got on the company grapevine and it began to appear that everybody was staying overtime. McKinsey, over the years, has found no gimmick that gives promise of any great success in the selection of prospective executives.

The company's experience shows specialized techniques need to be discarded in favor of only one, and that is the accumulation of a number of judgment appraisals as to whether or not the candidate has the characteristics you are looking for. This simply gets down to finding out from a group of people who have been exposed to him whether or not they have been able to identify in his make-up the characteristics you are looking for. This means that you will want to get the judgments of people who have worked with him in superior, subordinate, and equal positions both in industry and in avocational activities. You may want the judgments of people who are especially trained in selection, that is, personnel managers or industrial psychologists for example; and finally, of course you will want the judgments of the people who do the interviewing in your own firm.

If you have accumulated the judgments of competent people, you then have the only sound basis for determining whether or not the individual involved should properly be considered a prospective executive. Obviously in many cases this decision can only be reached over a period of time as these judgments accumulate and ripen.

Providing an Atmosphere for Executive Development

The term "executive training" may have unfortunate connotations to some people. The inference is that you train the candidate. This is something you can do to him or for him. In actual practice it more often works out that the result is more satisfactory where you as the top or senior management provide opportunities for the candidate to train or develop himself. Therefore, maybe the term "developing prospective executives" or "helping prospective executives to develop" creates a more accurate impression than does the use of the term training.

So this part of the discussion gets around to the question: What can you do to help a prospective executive develop to his full potential?

First, and most importantly, you must provide an atmosphere in your enterprise that is conducive to executive development. There are two phases to this matter of appropriate atmosphere.

Perhaps the most important is that you conduct this development in the setting of a well-run enterprise. It is unnecessarily difficult to develop an outstandingly competent executive candidate in a company that is poorly run and therefore relatively unsuccessful. Now what are the characteristics of a well-run business? This could certainly be the subject of discussion for the rest of the week, but let's enumerate the typical characteristics:

1. A clear and well-understood objective

2. Both a long-term and short-term management program typically undergirded with budgets to achieve that objective

3. A framework of sound and widely followed policies that implements the program

4. A clear plan of administrative organization that helps the management group work together more effectively in carrying out its program

5. An adequate management group staffing the organization planning

This group must be made up of executives who understand their responsibilities, who delegate freely, who are willing to make decisions and base them on fact, who prefer to be sound rather than expedient, who have learned to distinguish the important from the unimportant, and who are openminded, broad-gauged, and tolerant. This is one of the most important conditions because, of course, it is unreasonable to expect an attractive prospect to grow to his full potential among an executive group that is not talented or competent. The most serious complaint of the high-potential junior executives that McKinsey encounters is that they do not find the growth opportunities or the work satisfactions that they want in the shadow of the senior executive who is not doing his job well.

6. Finally, of course, there must be simple and adequate procedures to complete the characteristics of a well-run enterprise

The other phase of this matter of suitable atmosphere has to do with the attitude of the management group.

Are they genuinely interested in bringing along junior executives? Are they willing to spend time coaching and counseling them? Are they willing to bring them into top management discussions of important problems? Are they willing to delegate responsibility and authority? This is particularly important because it provides the atmosphere that gives the prospective executive a lot of work satisfaction. Equally important, it provides the opportunity for top management to check their judgment of the capacity of the candidate, because the best way to determine whether or not you really have a worth-while candidate is to observe him when he is "under load." In many cases the best way to test a man is the same as the best way to test a machine: put it under load and see how it performs. If you want to test a man's judgment give him some decisions to make.

Some companies find it necessary or desirable to add to their management group someone who is primarily responsible for executive development, who helps identify the worthwhile candidates in an orderly manner and then takes responsibility for the application of certain techniques that should expedite their development. One of the most important of these is job rotation. It is important, if it is at all possible, to circulate your better candidates through a series of positions of varying sizes and types to, on the one hand, add to their background and experience and, on the other hand, give you a further check on your judgments when you selected them for growth.

Finally, internally it is also important that you provide opportunity for advancement. Good candidates are of little value because they will not long stay with you if your avenues for advancement are blocked by over-age or incompetent incumbents. Some companies have worked out rather specific avenues for advancement and actually include in their organization manual the charts of typical career advancement patterns by way of putting emphasis on this important point. Incidentally, one of the author's fellow directors in the company, in connection with a recent talk that he was to make on a related subject, interviewed some 600 executives of promise with regard to their career attitudes. Nearly 70 percent of the respondents gave as the reason for staying with their present company, "opportunities for advancement look good." Nothing more really need be said about the importance of this to candidates.

Beyond the more or less informal and internal developmental opportunities for prospective executives, there is a wide and growing range of more or less formal external opportunities. The American Management Association, the National Industrial Conference Board, and other competent groups of that type conduct a very worth-while series of seminars and work shops for executives who want to grow. Your prospective executives should have opportunities to participate in activities of that type.

The leading Schools of Business—Harvard, Chicago, Columbia, Stanford—all offer executive development courses that are of real value to an attractive candidate.

Operators' Corner

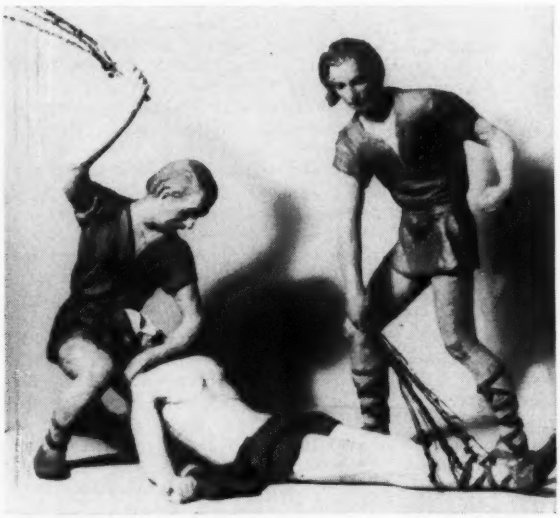
SOME OLD METHODS OF ARTIFICIAL RESPIRATION*

FOR CENTURIES, man has tried to discover a method to restore breathing after an accident has caused it to stop. The clay models pictured on these two pages show some of the various techniques used to solve the problem. With a few violent exceptions, some of them seem to be quite logical ways to restore breathing

** Courtesy of the Armco-operator*

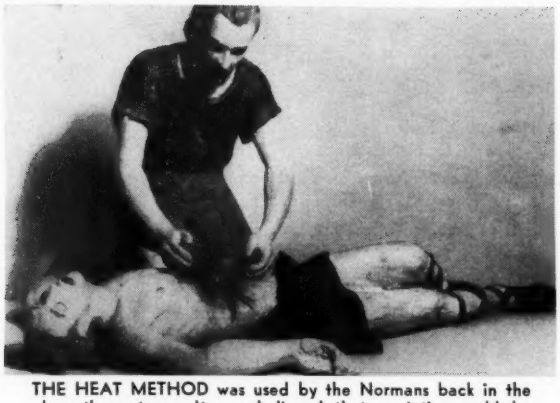
THE SUSPENDED METHOD was popular from 1760-1790. The victim was hung by his heels to force blood to his head in the hope that life would be restored

THE BARREL METHOD is still given today along the water fronts for victims in drowning cases. This practice of saving lives dates as far back as the year 1767



THE FLAGELLATION METHOD was also practiced from 1760-1790. The belief was that breathing would be stimulated if the entire body was whipped with nettles

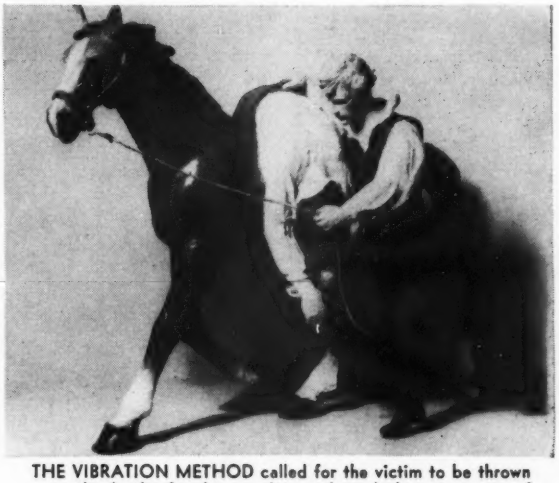
THE BOARD OR PLANK METHOD was used in the 1820's. This position must have created a terrific strain on the back of victim. Its success is undetermined



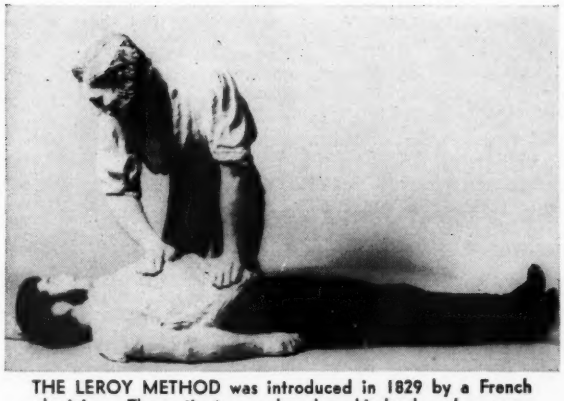
THE HEAT METHOD was used by the Normans back in the eleventh century. It was believed that a victim could be revived by building a fire on his body

FUMIGATION METHOD, practiced by the North American Indians, consisted of blowing smoke into an animal bladder and from there into the victim's rectum

THE BELLOWS METHOD, used in the sixteenth century, was based on the belief that air, when forced into the lungs through the mouth, would stimulate breathing



THE VIBRATION METHOD called for the victim to be thrown over the back of a horse. It was hoped the movement of the animal would induce breathing



THE LEROY METHOD was introduced in 1829 by a French physician. The patient was placed on his back and pressure was applied on the chest and stomach

THE SCHAFER PRONE PRESSURE METHOD, although newer methods have been introduced, is the most familiar type of artificial respiration. It was first introduced in 1903

PETTIBONE

UNIVERSAL WOBBLER

FEEDS AND SCALPS IN ONE OPERATION

won't clog in wet, sticky material

Elliptical-shaped bars form the bed of a hopper and are set in alternate vertical and horizontal positions. Turning of the bars imparts a rocking, tumbling forward motion to the load. Fines drop through spacing between bars. Oversize is delivered off the end.

The Wobbler Feeder increases crusher capacity by removing fines ahead of the crusher. Unlike a screen, the Wobbler does not vibrate — nor clog in wet, sticky material.

This combination feeder-scalper is needed in every mining operation. Here are a few uses now being made:

IRON ORE—The Wobbler is used as a portable machine to follow a shovel in reclaiming scattered ore stockpiles. Unwanted material is separated at the pile . . . usable ore is then trucked economically to mills and concentrating plants.

BAUXITE—A large number of Wobbler Feeders are being used by one of the Aluminum companies to separate fines from oversize in this gummy material — no clogging.

SLAG—The use of a Wobbler Feeder in place of a bar grizzly has cut grizzly maintenance from two days a week to four hours a month.

LIMESTONE—The Wobbler is removing 94% of fines ½-inch and under in the cement industry — for increased hammermill capacity.

Find out about the profitable experiences others have had with the Universal Wobbler. Visit our Booth No. 531, at the American Mining Congress, San Francisco, September 22 - 25.

PETTIBONE UNIVERSAL
In Cedar Rapids Since 1906

As Viewed by HARRY L. MOFFETT of the American Mining Congress

FOLLOWING a series of record-long sessions, the 85th Congress adjourned sine die at 4:11 a. m., Sunday morning, August 24. Unless a national emergency compels recall to Washington, Congress will not meet again until January 7, 1959, when the 86th Congress comes into being. All measures pending at the time of adjournment are dead.

Most observers feel that the 85th Congress was one of the most productive in history. Major legislation such as the revised Trade Agreements Act, foreign aid, Alaska statehood, a revised barter program, and heavy outlays for defense obtained Congressional sanction.

However, from a standpoint of domestic mining, the Congress did little that will aid many segments of the industry which have been hard-pressed as a result of a heavy influx of minerals and metals from abroad. The proposed minerals stabilization plan, despite the excellent efforts of mining-State lawmakers, went down to defeat in the House and other measures of some aid to mining were only of a minor nature. Strong efforts to obtain tariff aid for the mineral industries were made while the Trade Agreements Act was up for consideration but were unsuccessful. Senators and Representatives from mining States are to be highly complimented for the lengthy and strong efforts they made to obtain a national mineral program and it is hoped that they will renew their efforts in the next Congress.

FOUR-YEAR TRADE ACT APPROVED

President Eisenhower completed work on one of his major legislative triumphs when he signed into law last month a bill extending the trade agreements program for another four years —longest extension since the original Trade Agreements Act was enacted in 1934.

The new law, which the President hailed as a "firm forward step on the road to a stronger America in a world of peace," permits him to enter into trade agreements with other countries at any time up until July 1, 1962, and to reduce tariffs by as much as 20 percent. He cannot reduce a duty more than 10 percent in any one year; however, all but the initial portion of a reduction may become effective after the expiration of the four-year period.

Wider latitude is given the President in acting on escape-clause cases. He now can raise duties up to 50 percent above the rates in effect in 1934 rather than 1945 rates as in the past. If the 1934 rate was a specific figure, he can use its percentage equivalent which, as prices have risen since then, could result in a higher rate. He also could impose a duty of up to 50 percent of its value on an article not otherwise subject to duty.

A new provision would give Congress power, by a two-thirds vote of both Senate and House, to overturn a decision of the President in escape-clause cases. Most observers believe that any such action by Congress is highly unlikely.

Another provision broadens the factors which the President must consider in determining whether imports are threatening a defense-essential industry. The new factors include unemployment and the "investment, exploration, and development" necessary to assure an industry's growth.

HOUSE REJECTS STABILIZATION BILL

Legislation to stabilize domestic production of copper, lead, zinc, fluorspar and tungsten was defeated, 182 to 159, by the House just prior to the Session's end, thus dashing hopes of mining men who had urged that Congress take action to offset the harm done the industry by excessive and unneeded imports.

The blow came after three days of debate during which the plight of many mining areas was ably portrayed by Western Congressmen and others. Prior to the final vote, opposition forces were able to secure the adoption of amendments deleting tungsten and fluorspar provisions from the bill and seriously hamstringing the remainder of the program with financial limitations.

The Administration-backed measure, which had been overwhelmingly approved earlier by the Senate, would have provided for the stockpiling of 150,000 tons of copper, stabilization payments over a five-year period to domestic producers of lead, zinc, fluorspar and tungsten, and incentive payments on limited quantities of beryl, chrome and columbium-tantalum.

Immediately after the bill's defeat, Senators and Congressmen urged the President to act without further delay on Tariff Commission escape-clause recommendations that import duties on lead and zinc be raised. These recommendations, accompanied by a unanimous finding of the six Tariff Commissioners that the lead-zinc industry was being seriously injured

Washington Highlights

CONGRESS: Quits until January.
TRADE ACT: Approved by President.
MINERALS STABILIZATION PLAN: Defeated in House.
TVA: Bonding bill dies in Committee.
MINERALS EXPLORATION: Program continued.
LABOR REFORM: Pigeonholed in House.
MINERALS PURCHASE PROGRAMS: Vetoed.
ANTIDUMPING ACT: Revised.
COAL RESEARCH: House failed to act.
ANTITRUST BILLS: Held in Senate Committee.
PENSION LAW: Approved by Congress.
COAL LEASES: State limits hiked.
IRON ORE: Tariff study under way.
MERCURY AND TUNGSTEN: Hearings held.

by imports, were submitted to the President in April. Shortly thereafter the President announced that he was holding the recommendations in abeyance pending the outcome of Congressional action on the stabilization bill.

Under the Trade Agreements Act, the President has a free hand to impose all, part or none of the relief measures recommended by the Commission. The President has demonstrated in the past his reluctance to hike tariffs, and there is some doubt as to whether he will give the needed relief to the lead-zinc industry. Mining men are hopeful that he will, however, act favorably in this case, to assist the hard-hit domestic lead-zinc industries.

Some delay may occur in Presidential action because the Interim Co-ordinating Committee for International Commodity Arrangements—a United Nations organization—will meet in London beginning September 8 to consider problems in the world lead, zinc and copper industries. Some Administration spokesmen have indicated that the President may wish to withhold any action on the Tariff Commissioner's lead-zinc recommendations pending the outcome of the London conference.

TVA BONDING BILL DIES

A bill which would have permitted the Tennessee Valley Authority to issue $750 million in revenue bonds for the construction of generation and transmission facilities died in the House Rules Committee as Congress adjourned. The bill was opposed by the coal industry and others including members of the House Rules Committee.

Last-ditch efforts by proponents of the bill to pry it loose from this Committee failed but House Speaker Sam Rayburn told them that he will try to get House approval of such legislation early in the next session of Congress.

MINERALS EXPLORATION BILL SIGNED

A bill authorizing the Government to lend money to private industry for minerals exploration has been signed into law by the President. The program, which will be administered by a new Office of Minerals Exploration in the Department of the Interior, continues the functions of the now-defunct DMEA.

Under the new law, the Secretary of the Interior may determine the minerals eligible for exploration assistance and the proportion of the cost borne by the Government. Maximum Government participation in any one contract is $250,000.

The applicant is required to show that funds for the project are not available from commercial sources on reasonable terms. Loan repayment, with interest, is required through payment of royalties on any minerals produced from the project.

In providing $4 million for the new agency during the current fiscal year, Congress specified that loans could not exceed 50 percent of the cost of a project.

LABOR BILL DEFEATED

The mild labor reform bill which passed the Senate by an 88 to 1 vote was killed in the House during the final days of the last session when proponents tried to bring it up under a suspension of the rules. Not only did the bill not receive the ⅔ majority required for such a procedure, but it was defeated by eight votes on a simple majority 198 to 190.

The bill provided some minor reforms for internal operations of unions, but did not go to the heart of the problems revealed by the McClellan Rackets Committee such as union political activity, organizational picketing, or secondary boycotts. Because of these basic weaknesses, the bill was opposed generally by business and supported by a majority of organized

(Continued on page 84)

personals

Several changes have been made in management personnel of Cleveland-Cliffs Iron Co.

Walter A. Sterling has been elected chairman of the board as well as president. With the company since 1919, he was named vice president in 1950 and elected president in 1953.

H. Stuart Harrison, who had been vice president—finance, was elected executive vice president. Harrison joined Cleveland-Cliffs in 1937 and became treasurer in 1945 and a vice president in 1952.

W. A. Sterling

H. S. Harrison

James S. Westwater, manager of Michigan Mines at Ishpeming, Mich., has been made vice president—mining, succeeding **C. W. Allen,** who has resigned to join the Industry Resources Section of the International Cooperation Administration in Washington, D. C.

Westwater had been manager of Cliff's Michigan Mines since 1953 and has been with the company since 1940.

J. S. Westwater

H. J. Leach

Allen joined the iron mining company in 1925 as a mining engineer. He was named vice president in 1953.

Hugh J. Leach, who has been manager of Minnesota Mines, now becomes manager of Michigan Mines. **John J. Foucault,** formerly superintendent of the Holman-Cliffs Mine, succeeds Leach as manager of Minnesota Mines. **Stanley W. Sundeen** becomes manager, Research and Iron Ore Development.

Republic Coal & Coke Co. elected vice president **John M. Scott** to the office of executive vice-president of the corporation. A graduate of Northwestern University, Scott started his business career in the offices of Montgomery Ward & Co. Several years later he joined Walter Bledsoe & Co., remaining with that concern until 1941, when he became identified with Republic.

American Metal Climax, Inc. has announced the appointment of **Jerome Fuchs** as manager, systems and procedures for the company.

Robert R. Williams, Jr. has been elected president of the Rocky Mountain Coal Mining Institute for 1958-59. Williams, manager of mines for Colorado Fuel & Iron Corp., succeeds **Robert M. Van Storch,** general superintendent of mines and quarries for the Columbia-Geneva Steel division of U. S. Steel Corp.

On August 1 **G. F. Coope** retired as president of Potash Co. of America. He remains on the board of directors and the executive committee and will also act as consultant for the company. Coope has been with Potash Co. of America for almost 22 years.

He is succeeded by **F. O. Davis,** formerly executive vice president and treasurer.

G. F. Coope

F. O. Davis

1959 AMC Coal Show

Acceptance by E. P. Humphrey, president of Stonega Coke & Coal Co. and Westmoreland Coal Co., of the chairmanship of the Program Committee for the 1959 Coal Show of the American Mining Congress signals the acceleration of plans for this most important meeting of the coal mining industry. Mr. Humphrey will head a nation-wide committee of coal mine operators and equipment manufacturers in the important task of selecting subjects and speakers for the Convention. This group will be charged with the responsibility of determining how best to bring the industry up to date on the latest advances in methods and equipment for mining and preparing coal.

Anyone wishing to suggest a topic for discussion at the 1959 Coal Show should write the American Mining Congress, Ring Building, Washington 6, D. C. In mid-November the Program Committee will meet to consider all of the suggestions received and to draw up a comprehensive, well-rounded program.

Equipment manufacturers have long been making plans for next year's Coal Show and many are preparing to present new products at that time. All types of equipment, including machinery and supplies designed for use in the many phases of underground and strip mining, as well as in preparation plants, maintenance shops and power systems, will be exhibited.

Richard S. Newlin, vice president in charge of operations of the Anaconda Co., has been elected president and director of Anaconda's 99 percent-owned subsidiary Greene-Cananea Copper Co.

Anaconda has also announced that **James F. Smith** has been named manager of the Anaconda Aluminum Reduction Works at Columbia Falls, Mont., succeeding **Howard G. Satterthwaite,** retired.

R. S. Newlin

J. F. Smith

Before his assignment at Columbia Falls, Smith was assistant superintendent of Anaconda's Great Falls, Mont. copper refinery.

Satterthwaite has been in charge of the aluminum plant since construction began in 1952 and operations commenced in 1955.

Director **Marling J. Ankeny** of the U. S. Bureau of Mines named a five-man organizing group to select committee chairmen for the 1959 National First-Aid and Mine-Rescue Contest. He chose **Harry Gandy, Jr.,** National Coal Association; **Charles Ferguson,** United Mine Workers of America; **James B. Benson,** Southern Coal Producers' Association; **George C. Trevorrow,** Bituminous Coal Operators' Association; and **James Westfield,** Bureau of Mines.

Hugo E. Johnson has been elected president of the American Iron Ore Association. He succeeds **Franklin G. Pardee,** who is retiring.

Johnson has been with the association since 1954, first as vice president, more recently as vice president and secretary. Between 1948 and 1954, he was assistant manager of the project development group at Battelle Memorial Institute, Columbus, Ohio, engaged in research and development programs in raw materials mining and utilization for the iron and steel industry.

H. E. Johnson

F. G. Pardee

Pardee has been president of the association since 1952. Well-known throughout the iron ore mining industry, he had previously been State geologist and appraiser of mines for Michigan. He plans to make his home in Crystal Falls, Mich., where he will open an office as consulting mining engineer and geologist.

Ralph R. Basler, formerly production superintendent and chief engineer of the South Dakota Cement Co., has been named to the newly-created post of plant manager at Cape Girardeau, Mo., for Marquette Cement Manufacturing Co.

At the same time it was announced that **David G. Lewis** had been named quarry superintendent at the Superior, Ohio, plant.

— *Obituaries* —

Kenneth C. Brownell, 55, chairman of the board of American Smelting & Refining Co., died August 4 in New York.

K. C. Brownell

A native of Everett, Wash., Mr. Brownell joined the American Smelting & Refining Co. in 1927 in the ore purchasing department. From there he went to the sales department to become vice president in 1936. In 1947 he was elected to the newly created office of executive vice president and in 1949 he became president. He was named chairman of the board and chief executive officer in 1957.

In addition to his many-fold duties with Asarco, Mr. Brownell was active in other business, financial and charitable organizations. He was a director of Revere Copper & Brass, Inc., General Cable Corp., the Chase Manhattan Bank of New York, the Great Northern Paper Co. and the First National Bank of Greenwich, Conn. He was a trustee of the Rockefeller Institute for Medical Research and a vice president and trustee of the John Simon Guggenheim Memorial Foundation.

Milton T. Smith, 57, former president and general manager of the Marion Power Shovel Co., died unexpectedly July 12 while driving between Charlottesville, Va., and Marion, Ohio.

M. T. Smith

A veteran of long service in the power shovel industry, Mr. Smith was associated with Bucyrus-Erie Co. before joining Marion Power Shovel in 1954. He had retired June 21 as president of the Marion Co. and had moved to Charlottesville.

George G. Gallagher, 58, technical advisor to the Division of Raw Materials Division, Atomic Energy Commission, died recently in Washington, D. C., after an illness of several months.

Born in Leicester, Mass., Mr. Gallagher spent most of his mining career in the West. He was associated for a number of years with the United Verde Copper Co. and in 1936 went to the Grass Valley gold mining district of California where he was superintendent of the Banner mine for the Lava Cap Gold Mining Corp. He spent a short time in the Mother Lode district and at the beginning of World War II joined the staff of the Mining Division of the Reconstruction Finance Corp. where he remained until the end of the war. After spending a year in Mexico, he returned to Washington in 1949 with the Atomic Energy Commission, where he remained until his untimely death.

G. G. Gallagher

Michael Patrick Cloonan, 67, Colorado mining engineer and former president of the Colorado Mining Association, died July 15. Mr. Cloonan suffered a heart attack aboard a flight from Denver to Washington, D. C. where he was going in behalf of Colorado lead and zinc interests.

Harold W. Dauber, 53, manager of marketing services for the Mining & International Divisions of Mine Safety Appliances Co., died July 8 from injuries received in an auto accident July 3.

William Blizzard, 65, retired president of District 17, United Mine Workers of America, died July 31.

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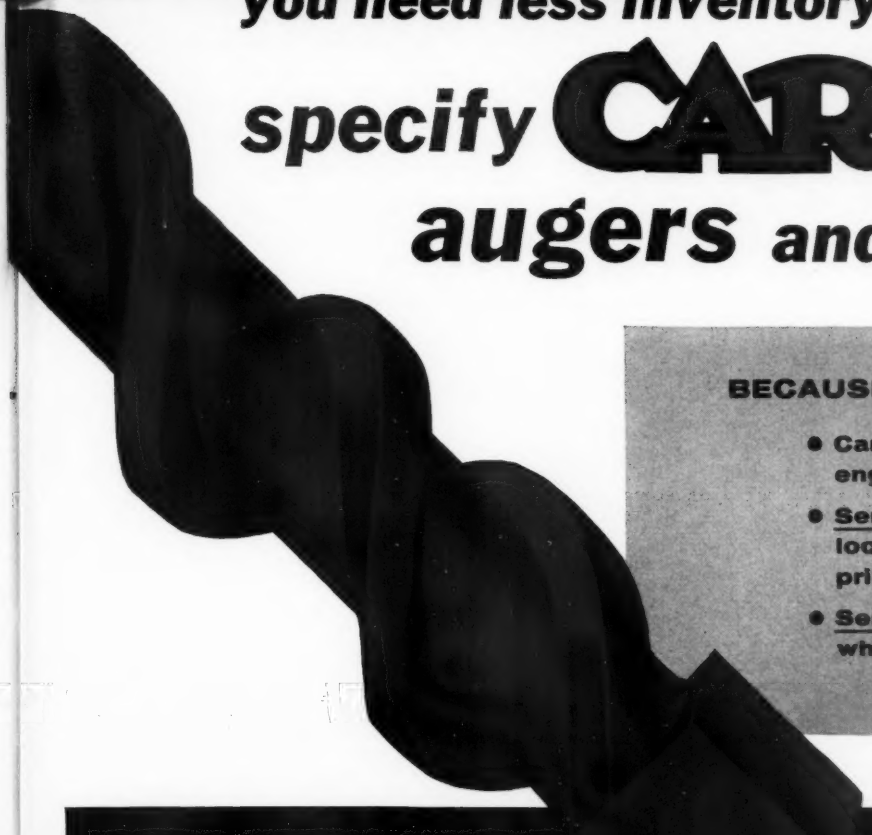

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NEWS and views

Standard for Prevention of Dust Explosions in Coal Preparation Plants

Fires and explosions that have occurred in coal preparation plants have resulted in the issuance of a new standard by the National Fire Protection Association.

The new standard covers building construction and arrangement for plants producing conditioned coal for firing of boilers or power generating plants. The standard also gives details on how to prevent dust explosions and machines and equipment used for screening, crushing, pulverizing, drying and conveying the treated coal. Information on explosion venting, fire fighting equipment and lightning protection are also included.

Copies of the standard (NFPA No. 653, 20 pages, 50 cents) are available from the National Fire Protection Association, 60 Batterymarch St., Boston, Mass.

IMC Works Unusual Mica Deposit

Full production of flake mica from the largest known source of raw material in the country was recently started by International Minerals & Chemical Corp. With completion of an expansion program to provide additional grinding capacity, the company's plant on Davy Crockett Lake near Greeneville, Tenn., has increased production potential from a pilot plant stage of 24 tons to full capacity of 120 tons a day.

Source of supply for the plant is a deposit of mica-bearing silt that has been accumulating for over 50 years in a five-mile delta in Davy Crockett Lake about six miles upstream from the Tennessee Valley Authority's Nolichucky Dam. The company spent a year perfecting means of dredging, screening, and separating the mineral. A specially-constructed $30,000 dredge, brought to the lake in parts, sucks up the silt and feeds it into a conduit which carries the fluid material to the processing plant. The flotation recovery system in use was developed by IMC for this particular plant.

Completed in 1957, the plant represents a total investment of more than half a million dollars.

Coal Firm to Manufacture Lightweight Aggregate

Clinchfield Coal Co., a division of the Pittston, Co., has scheduled construction of a $1,500,000 lightweight aggregate manufacturing plant at Clinchfield, Va.

The plant is part of Clinchfield's $20,000,000 expansion program in the southwest Virginia area, which includes construction of Moss No. 3 mine and one of the world's largest coal preparation plants.

Lightweight aggregate, to be named Clinchlite, will be manufactured from the shale washed from coal in the new preparation plant.

Coal Industry 80 Percent Efficient

The American bituminous coal industry loses $250,000,000 a year because it is only 80 percent efficient, according to a Harvard University economist.

In a book, *The Efficiency of the Coal Industry*, recently published by the Harvard University Press, assistant professor James M. Henderson says two of the biggest factors are overcapacity and the excess number of small firms in the field.

Prof. Henderson applied a mathematic system called "linear programming" to find the most efficient method of doing a job with the least expenditure of manpower and materials.

He found that the troubles of industry were due in part to overcapacity—more companies and more miners than necessary to produce the coal requirements of the country.

Bauxite Storage Building

Approximately 235,000 sq ft of corrugated aluminum box ribbed siding and roofing sheet was used to cover this large storage building at Kaiser Aluminum & Chemical Corporation's new Gramercy, La., plant. The building is designed to store up to 132,000 long wet tons of bauxite ore. Ore is delivered to the top of the building by a 54-in. wide conveyor line and dumped on the pile by a remotely controlled reversible shuttle conveyor located at the roof ridge and running the length of the building. Recovery is made through two reclaim tunnels.

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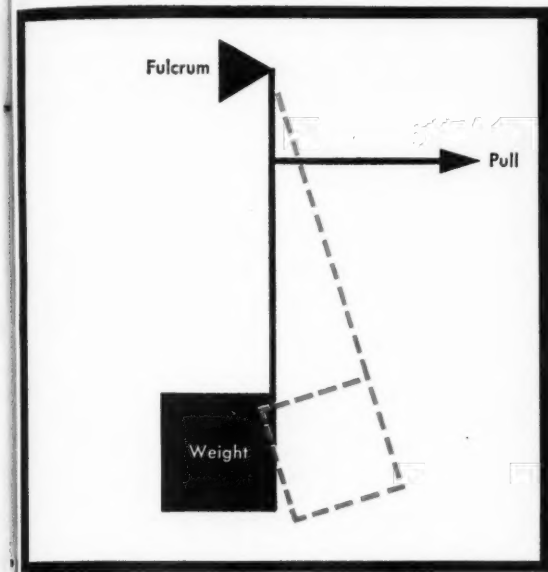

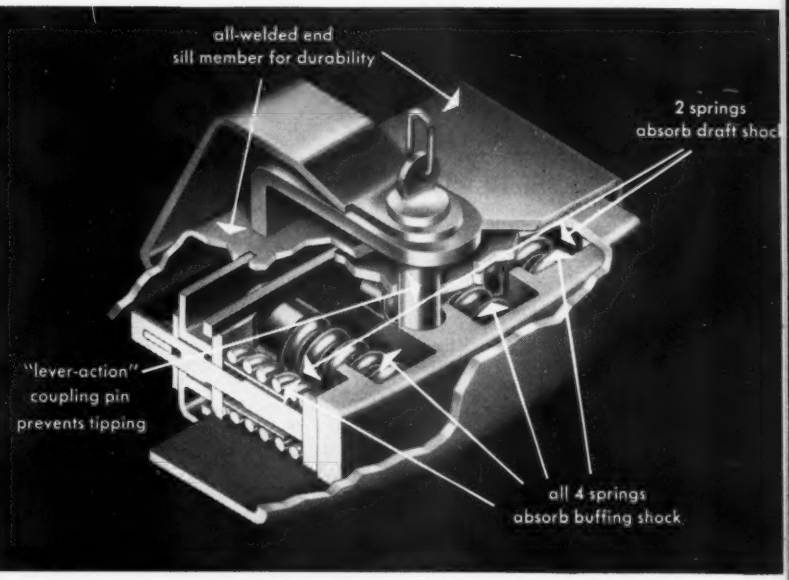

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ALSO . . .

One of New York's newest skyscrapers, the 52-story Union Carbide Building, will be "floating on lead," according to the Lead Industries Association. An anti-vibration move, "floating on lead" is accomplished by having each of the 115 supporting steel columns rest on lead pads. These lead anti-vibration pads are designed to isolate the building from heavy rail traffic passing directly under the building on its way into Grand Central Station.

The association also announced that approximately 1,000,000 lb of 1/16-in. thick sheet lead will be used as a lubricating base and seal beneath the walls of water-conveying conduits for the New York State Power Authority's Niagara Power Project.

The twenty-first annual ASME-AIME Joint Solid Fuels Conference is scheduled to be held on October 9-10, at the Hotel Chamberlin, Old Point Comfort, Va., several miles east of Newport News. One of the highlights of the meeting will be a tour of the coal-loading facilities at Port of Hampton Roads, Va., where last year the three Pocahontas coal-carrying railroads dumped in excess of 60,500,000 tons of coal into sea-going vessels.

National Gypsum Co. recently climaxed five years of intensive exploration, development, design and construction with the completion of its multi-million dollar asbestos mine and mill at Thetford Mines, Quebec. The new facility has a daily ore capacity of 3000 tons and will produce 50,000 tons of asbestos fiber annually. The parent company operates the new asbestos plant—known as National Asbestos Mines, Ltd.—through its wholly owned Canadian subsidiary, National Gypsum Canada, Ltd.

The Southern Coal Producers Association, which has maintained offices in Charleston since it was organized 16 years ago, has announced the West Virginia offices were moved to Washington August 1. The Association represents operating companies in the coal industry of southern West Virginia, eastern Kentucky, western Virginia and Tennessee.

At Hazleton, Pa., the nation's first integrated privately-owned plant for the fabrication of beryllium metal has been put into operation by The Berryllium Corp. The company recently completed the facility adjacent to its large reconstructed plant for the production of beryllium metal. Previously, the only complete beryllium fabricating plant in the nation was owned by the U. S. Atomic Energy Commission. While the bulk of the new plant's output will be directed toward the nuclear market, it will also produce experimental shapes for aircraft research and development.

Representatives of Chicago and Pittsburgh area steel companies and Illinois coal producers had a preview of the latest developments in coal and coke research conducted by the Illinois State Geological Survey at the Spring meeting of the Coal Advisory Committee at the University of Illinois. Special demonstrations and laboratory tours highlighting the meeting were arranged to acquaint the steel industry with the research program. Discussion of chemical quality, heating properties, and physical constituents of Illinois coal related to its utilization by industry followed the demonstrations.

The 46th National Safety Congress will be held in Chicago, Ill., October 20-24. The Congress—annual convention of the National Safety Council—will have 300 sessions and 900 speakers. Sessions pertaining to all fields of industrial safety will be held during the five-day convention.

Michigan Chemical Corp. has announced the completion of plans for the construction of a new seawater magnesia plant at Port St. Joe, Fla. The new plant, with a design capacity of 125 to 150 tons a day and a subsequent enlargement to 300 tons, will provide industry with high-purity chemical and refractory grades of magnesium oxide and will have access to rail, ocean, and Mississippi River barge shipping.

Reynolds Metals Company's $70,000,000 aluminum reduction plant at Listerhill, Ala., has gone into full production following the recent turning on of power for the third big potline. The first of the three lines which made up the expansion program of the Listerhill works went into production in mid-January, followed shortly by completion and operation of the second. Rated capacity of the three new lines amounts to 112,500 tons of virgin aluminum a year; added to the existing facilities consisting of five older lines, capacity of the Listerhill works is increased to 190,000 tons.

Full-scale experiments in preparing and blending coal for coke ovens and measuring the recovery of gas and coal chemicals will begin soon at U. S. Steel Corporation's Clairton Works with the building of a pilot plant. To be housed in a building now under construction, the plant will be able to operate at a maximum rate of 50 tph. After special preparation of the coal, results of the coking process will be analyzed in five commercial size coke ovens.

American Zinc Institute recently published the first issue of its new quarterly newsletter, *The Zinc Spotlight*. According to Simon D. Strauss, president of AZI, the four-page publication has been created to bring a wide variety of news about zinc and the zinc industry of special interest to engineers, designers, fabricators, management and students. The newsletter may be obtained free of charge by writing American Zinc Institute, Inc., 60 East 42nd St., New York 17, N. Y.

A dense media washer plant was recently put into operation at the MacAlpin mine of Winding Gulf Coals, Inc. The plant is located in Raleigh County, W. Va.

Cleveland-Cliffs Iron Co., which operates iron ore mines in Michigan and Minnesota, has been named agent for three University of Wisconsin instructors who have negotiated an exploratory easement with Juneau County and others in Wisconsin. Based on magnetic and gravity anomalies which they mapped, the University group believes that iron-bearing material may occur deep under the surface in Juneau County. Cleveland-Cliffs will explore to prove or disprove the presence of iron.

A geologist believes North Carolina should take steps to mine 66,000,000 tons of coal he estimates is recoverable in the Deep River section of Chatham and Lee Counties. Dr. Jasper L. Stucky made the estimate in a report to the Mineral Resources Board of the State Department of Conservation and Development. One difficulty which will be encountered in mining the potential fuel, he said, is that cross faults ranging from 20 to 150 ft occur along the vein.

United States Steel Corp. has announced it will install a major addition to its strip steel processing equipment at the division's Fairfield, Ala., tin mill. The new facility will be a continuous annealing or heat treatment line which enables steel strip to be heated up to 1350°F in the process of preparing it for rolling to the required thickness for tin plate products. Engineering for the 457-ft strip is now in progress, and actual construction will start as soon as the planning phase is completed.

The Wood Pocahontas Coal Co. mine at Besoco, W. Va., has suspended operations for an indefinite period. The Besoco operation had been, in the past, one of the largest mines in Raleigh County.

Annual Coal Division Conference

Pittsburgh, Pa., Friday, November 14, 1958

Coal mining men, manufacturers of mining equipment and all others interested in the mining of coal are cordially invited to attend the Annual Conference of the American Mining Congress' Coal Division on November 15 at the Penn Sheraton Hotel in Pittsburgh. The seven committees of the Coal Division will report on work that has been completed this year and will discuss the progress of current studies. Primary purpose of the meeting is to outline the work of the various Coal Division committees and subcommittees and to encourage the free interchange of information that is so important to advancing technology in any industry.

In their work of developing and disseminating data on problems vital to the industry, the Coal Division committees study the practical application of mining machines and methods to determine what is required for successful operation under widely varying conditions. The broad range of subjects to be covered at the November 14 meeting includes: Washery Water Clarification; An Analysis of Cleaning Plant Start-Up Problems; Dust Control in Continuous Mining; Mining Plans; Roof Bolt Anchorage Testing Standards; Drill Bit Size Coding; A-C Power Underground; Safety Practices; Future Demands on Section Haulage; Dust Abatement on Strip Mine Haulage Roads; Ammonium Nitrate Blasting, and Increasing Wire Rope Life.

Committees and their chairmen are:

Committee on Coal Preparation
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Eastern Gas & Fuel Associates

Committee on Mechanical Mining
WILLIAM E. HESS,
Jones & Laughlin Steel Corp.

Committee on Mine Haulage
A. G. GOSSARD,
Snow Hill Coal Corp.

Committee on Roof Action
J. A. BROOKES,
Mather Collieries,
Pickands Mather & Co.

Committee on Mine Safety
RALPH KIRK,
Consulting Engineer,
Birmingham, Ala.

Committee on Strip Mining
E. R. PHELPS,
Pittsburg & Midway Coal Mining Co.

Committee on Underground Power
J. A. DUNN,
Island Creek Coal Co.

Titanium Metals Corp., jointly owned by Allegheny Ludlum Steel Corp. and National Lead Co., has expanded its operations in Europe by forming with Deutsche Edelstahlwerke (DEW), a German specialty steel producer, a jointly owned titanium company. The new company, Continental Titanium Metals Corp., will produce and market titanium metals in Europe. The firm will be headquartered in Luxembourg, while production will be at DEW's 7000-man plant in Krefeld, West Germany.

A new diesel towboat has been added to Consolidation Coal Company's fleet. Built at Dravo Corporation's Neville Island shipyards, the 132-ft, 1600-hp vessel has been christened the "Humphrey" in honor of George M. Humphrey, former Secretary of the Treasury and a director of Consolidation Coal. The Humphrey will move barges between mines on the Monongahela and Allegheny rivers and customers' plants on both the Monongahela and Ohio rivers.

Steep Rock Iron Mines Ltd. has brought into production a new $2,250,000 ore-improvement plant, the first of its kind in Canada. The Steep Rock, Ontario, plant is capable of processing 7000 tons of crude ore daily, producing 5500 tons of high grade ore. It also can be used to blend ore types to customers' requests.

A historical marker was recently placed at the Huron Portland Cement Co. at Alpena, Mich., marking the site of one of the world's largest cement plants. The Michigan Historical Commission said the plaque will recognize the company's contributions to Michigan's growth in the last 50 years. Cement production began at the plant in 1908.

One of the steel industry's largest sintering plants, capable of producing more than 6000 tons per day, has been placed in operation at Weirton Steel Co., Weirton, Ohio. The new plant can produce 3½ tons per sq ft of hearth and incorporates such features as a radiant type furnace for firing the mix.

Twenty years from now the United States will still be depending upon coal and oil to supply its growing energy needs, according to a recent National Planning Association study. Atomic energy will be contributing only about ten percent of the total energy consumed, or the equivalent of some 270,000,000 tons of coal out of a total of 3 billion. The study suggests the United States may even have to tackle the problem of tapping energy from the sun and using controlled thermonuclear fusion or H-power.

(Continued on page 86)

ALSO . . .

(Continued from page 84)

Columbia-Southern Chemical Corp. has begun construction of a cement plant at Barberton, Ohio. Designed to produce 1,500,000 bbl of cement annually, the multi-million-dollar plant will include a rotary kiln 450-ft long and 13 ft in diameter. When in operation, this kiln will be one of the largest moving pieces of equipment in the United States. The plant is scheduled for completion in December 1959.

The Black Eagle mine of the Amigo Smokeless Coal Co., closed down since March, has resumed operations. The mine is located in Wyoming County, W. Va.

WHEELS OF GOVERNMENT

(Continued from page 76)

labor leaders.

Proponents attempted to bring the bill to the House floor under a suspension of the rules because earlier the House Education and Labor Committee had voted not to report it to the House under the regular procedure.

PRESIDENT VETOES MINERALS BILL

The President recently vetoed a bill which provided for a one year extension of the asbestos and fluorspar provisions of the Domestic Tungsten, Asbestos, Fluorspar and Columbium-Tantalum Production and Purchase Act of 1956. The program is due to expire December 31, 1958.

The President said "the stabilization program for acid-grade fluorspar, if enacted in this session of the Congress, will go into effect on October 1, 1958, subject to the availability of funds, just prior to the termination dates of the Public Law 733 program. The maintenance of two programs for this commodity with contradictory objectives would be ill-advised." Regarding asbestos, the President said, "the enrolled bill would simply extend the time limitation of the program without increasing the quantitative limitation. On the basis of the present rates of delivery of this material under the Public Law 733 program, the quantitative limitation will be achieved prior to the termination of the existing legislation."

ANTIDUMPING ACT AMENDED

The President has signed a bill amending the Antidumping Act of 1921, which according to Treasury Department officials will assist in penalizing foreign exporters who sell in the United States market at less than fair value.

As a result of court decisions and interpretations by the Treasury Department it has been possible for foreign exporters to sell in foreign markets with fictitious restrictions at one price and in the U. S. market at a lower price and although dumping and injury could be found the Treasury Department could not assess the additional dumping charges. The amendments provide that such fictitious sales can be ignored by appraising officers. Also the new law provides that if the Tariff Commission splits evenly, it will be held that "injury" has been suffered by domestic industry as a result of the dumping.

COAL RESEARCH BILL DIES

A bill providing for the establishment of a Coal Research and Development Commission passed the Senate in the final days of the session, but the House failed to act on a similar measure which had been reported favorably by the House Interior and Insular Affairs Committee.

Endorsed by the American Mining Congress and others, the bill was directed at an over-all research program to encourage and stimulate the production and consumption of coal. A Commission and an Advisory Committee would have been appointed to carry out the program.

ANTITRUST BILLS DIE IN COMMITTEE

Two bills opposed by the American Mining Congress and others died in the Senate Judiciary Committee with adjournment of Congress. They were the so-called price discrimination bill, S. 11, and S. 198 which would have required prior notification to the Attorney General and the Federal Trade Commission of proposed mergers or acquisitions by concerns with combined assets of $10 million. The price discrimination bill, which would have nullified the "good faith" defense in price discrimination cases had been amended to be applicable to only food, drug and cosmetic items and the notification bill had been amended to exempt acquisitions of reserves by mining companies.

PENSION REPORTING BILL PROGRESSES

The House and Senate have agreed on a bill to require the public disclosure of welfare and pension plans whether administered by unions, by management, or jointly managed. The bill, which has been sent to the President for signature, is much less stringent than one which passed the Senate earlier this year.

As approved by the Congress, welfare and pension plan administrators would be required to furnish all those covered by such plans a detailed analysis of the liabilities, assets and general financial operations of the plans. A copy of such report must be filed with the Secretary of Labor, but he would have no regulatory authority as he had under the Senate bill.

The Senate and House agreed that plans covering 25 or fewer persons should be exempted from the disclosure regulations.

INCREASED COAL LANDS APPROVED

The President has signed into law legislation which will permit the holding in any one State by a corporation, individual or company, public land coal leases up to 10,240 acres instead of the 5,120 acres as under the present law.

The House and Senate agreed that an additional 5,120 acres may be held in any one State after a public hearing to determine whether a lease or permit would be in the public interest and is necessary for the applicant's business. Such lease would be cancellable if not in the public interest or the extra acreage is not required for the lessee's business.

IRON ORE STUDY STARTED

As the result of a Senate Finance Committee resolution, the Tariff Commission has initiated a study of imports of iron ore and their impact on the domestic iron ore industry. The resolution was requested by Senator Thye (Rep., Minn.) and the Commission is required to report on their findings only, without making any recommendations.

The resolution provided that in its report the Commission "shall set forth a summary of the facts obtained in the investigation, including a description of the domestic industry, domestic production, foreign production, imports (including sources of imports), consumption, channels of distribution, United States exports, prices of domestic and imported ores, and the United States customs treatment (including trade agreement obligations with respect to such treatment) since 1930."

The Commission must complete its report by March 1, 1959.

MERCURY AND TUNGSTEN HEARINGS

As directed by the Senate Finance Committee, the Tariff Commission has completed an investigation of the competition between domestic and foreign producers of tungsten and mercury. The hearings were held merely to advise the Senate Committee of conditions of employment, domestic production, imports, consumption and customs treatment of foreign production and no recommendation for relief will be made by the Commission.

Appearing in behalf of the domestic tungsten industry were F. A. McGonigle, Tungsten Mining Corp., and Charles H. Segerstrom, Jr., Nevada-Massachusetts Co. Presenting the case for domestic mercury producers were S. H. Williston and J. Eldon Gilbert, Codero Mining Co.; S. R. Smith, American Quicksilver Institute; Gordon I. Gould, Gordon I. Gould Co.; M. H. Kline, Rare Metals Corp.; Harold Biaggini, Buena Vista Mine, and C. Hyde Lewis, New Idria Mining & Chemical Co.

NEWS and views

Thorium Operations Planned

Plans for new thorium operations have been announced by three companies.

Nuclear Fuels & Rare Metals Corp., Inc., plans to develop large reserves of thorium ore in Idaho. The company controls about 7500 acres located on the Continental Divide between Idaho and Montana, in the Lemhi Pass area. Open-pit mining of the vein-type ore is planned.

The first thorium mill in North America will be built in the Blind River area of Canada north of Sault Ste. Marie, Mich., by Rio Tinto Dow Ltd. The mill will produce crude thorium concentrates and refined metallurgical grades of thorium sulphate and thorium oxide. The thorium minerals are by-products from uranium mining operations in the Blind River-Algoma area of Canada.

Idaho Mining & Milling, Inc., is planning extensive development of large placer holdings in the Florence Basin of Idaho County. The company is planning to install a shallow-type bucket elevator dredge with a capacity of 2000-yd per day. Gold will be the principal product, but heavy sands including monazite, zircon, garnet and radioactive "blacks" will also be recovered.

New Developments in Oil Shale

A new process for recovering oil from shale has been announced by the Research Institute of the University of Denver. Officials of the Institute said the so-called Aspeco process was the result of two years of research and development for Oil Shale Corp., of Carson City, Nev. The new process reportedly offers considerable promise for future shale oil development.

Recently the Union Oil Co., of California, shut down its multi-million dollar retort plant near Grand Valley, Colo., but announced the plant could be quickly put into operation in the event any emergency cut down on oil supply to this country. Following Union Oil's closure, the U. S. Bureau of Mines speculated that the Bureau's shale oil plant at Rifle, Colo., might be re-opened for research purposes.

Beryllium Interest Increases

Beryllium continues to be in the news. There has been considerable activity recently in the Crystal Mountain area near Loveland, Colo. American Beryllium Corp., Cordillera Mining Co., Estes Park Beryllium Corp., and Mineral Concentrates, Inc., are active in that area. All companies have mills and mines either planned or in operation.

The daily production of beryllium ore from Colorado, approximately 350 to 400 tons per day, is equal to the total known world production of the metal only two years ago. William Dansby, president of the Beryllium Association, said mining successes in Colorado now guarantee this country a supply of beryllium for the next 30 years. He further stated that the metal will open the door to new nuclear space-age advances.

The U. S. Bureau of Mines has announced a stepped-up search for domestic sources of beryl, coupled with mining and metallurgical studies aimed at supplying needs in the missile, aircraft, and atomic energy fields. As part of this nationwide hunt for beryl deposits, the Bureau will increase cataloging, classifying, and evaluating all known occurrences of the mineral and re-examine all known pegmatite areas for beryl and associated minerals. The Bureau will also seek improved methods for detecting, mining and recovering beryl minerals and processing beryl concentrates.

In addition, the nation's first integrated privately-owned plant for the fabrication of beryllium metal was put into operation by Beryllium Corp. at Hazleton, Pa. "Initial operation of our facility means that another of the formerly rare metals of the atomic age has passed into the domain of private industry," Walter R. Lowry, president of the corporation said. The corporation plans to follow an aggressive research program directed to further process improvement and cost reduction.

Beryllium is an important component of space-age aircraft and missiles, because it is only half as heavy as aluminum, possesses great strength, and can withstand extremely high temperatures.

Uranium Contract Amended and Extended

The Atomic Energy Commission and Texas-Zinc Minerals Corp. have signed an amended contract which provides for treating increased amounts of ores from independent producers at the Texas-Zinc Mill in Mexican Hat, Utah. The contract also provides for the purchase of Commission-owned ore stockpiles at White Canyon, Utah, and the extension of the contract from March, 1962, to December 31, 1966.

This is the first such action by the Commission to implement the policy announced April 2, 1958, to expand to a limited extent domestic uranium procurement, thus providing markets for those areas which had no markets, or had an inadequate market for ore reserves developed prior to November 1, 1957.

The Commission's decision resulted from a survey conducted by the Grand Junction Operations Office which was completed on March 31, 1958. The survey showed that in the White Canyon-Monument Valley area, milling capacity was sufficient if arrangements could be made for treating independent ores at a higher rate.

Whereas the original Mexican Hat milling contract called for the plant to treat approximately 4600 tons of custom, or independent ores, per month, the amended contract will provide a market for about 13,000 tons of independent ores. Reserves in the White Canyon-Monument Valley area were estimated at 1,869,000 tons as of November 1, 1957.

ALSO . . .

The Homestake-Sapin 1500 tpd uranium processing mill at Grants, N. M., recently produced its first uranium concentrate. After a brief break-in period and minor alterations, the mill placed one 750-tpd unit in continuous operation. Homestake-Sapin Partners is a limited partnership with Homestake Mining Co. and Sabre-Pinon Corp. Ore for the new mill is being supplied from the partnership's properties in the Ambrosia Lake area.

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The first uranium mill for Colorado Front Range ore started operations recently. The mill is located at Canon City, Colo., and is owned by Cotter Corp. The 70-tpd pilot plant signals the start of a solid market for ore produced in the Denver-Golden area. The company is already in negotiations with the Atomic Energy Commission to secure approval for construction of a 200-tpd mill. The new pilot plant uses a process developed at Colorado School of Mines especially for treatment of ore from the Schwartzwalder mine of Denver-Golden Oil & Uranium Co.

More than $100,000 will be spent by Calera Mining Co. exploring a cobalt-copper deposit at the Sunshine claims in Lemhi County, Idaho, under a DMEA contract. Government participation will be 62½ percent. Calera, currently producing cobalt and copper at the Blackbird mine in Lemhi County, is a subsidiary of Howe Sound Co.

Plans for a new $200,000 iron ore processing plant in Cheyenne, Wyo., have been announced by Western Steel, Inc. The plant will produce iron powder to be used in fabrication of gears, bushings and other machinery parts. Ore for the plant will come from Magnetite Products Corp., which has an operating iron mine on Sybille Creek, about 100 miles west of Cheyenne.

The proposed $25,000,000 potash mine and mill of Delhi-Taylor Oil Corp. of Dallas, Texas, to be developed near Moab, Utah, moved one step nearer to reality. A 50-year Federal power reserve restriction was lifted by the solicitor's office of the Department of the Interior. This clearance was necessary before Delhi-Taylor could proceed any further. The potash beds and mill site are on an area previously withdrawn for some future power development of the Colorado River. The company has no definite plans at this time as to when they will begin development of the property.

Copperfield, Utah, a town that once had a population of nearly 2000 persons, is being removed to make way for expanding mining operations of Kennecott Copper Corp.

A new 3-compartment shaft will be sunk on the Conjecture silver mine of Federal Uranium Corp. The mine is located in the Coeur d'Alene district of northern Idaho.

Ground has been broken for the Nevada Cement Corporation's new $3,000,000 cement plant at Mill City, Nev. Initial design capacity of the proposed plant is 500,000 bbl per yr. Limestone will come from extensive nearby deposits.

An unusual model has been constructed to aid in the solution of the complex and controversial problems involved in the proposal to build a dam at Boundary Site on the Pend Oreille River in the Metaline Mining District of northeastern Washington. An important source of zinc and lead, the district has two mines, one owned by Pend Oreille Mines & Metals Co. and the other by American Zinc Lead & Smelting Co., that are active at the present time. Numerous prospects and marginal operations are also located in the district.

The City of Seattle Department of Lighting proposes to build a dam to store water in the river. Some mining companies have vigorously opposed City's application for license to the Federal Power Commission to construct this hydroelectric project, claiming that some, if not all, of the mining area below the reservoir would have to be abandoned. The operator of the proposed reservoir might face liabilities should the mining properties be damaged by the higher river water level.

The model, constructed by City's consultants, Wisser & Cox of San Francisco, is in three pieces, each approximately four by four ft. Each piece is mounted in a formica box with a top for easy transporting. The top surface of the model is molded in opaque plastic to conform with the topographic contours at a scale of 500 ft to the in. Below the opaque plastic, which is painted to represent the natural land surface conditions, is a transparent plastic duplicate top. Certain geologic features are portrayed on the transparent surface. A change in water level can be shown by removal of the plastic insert. The mine workings are shown by copper-plated solid models correctly positioned below the land surface. Drill holes are shown by vertical pegs. The complex geology is shown by transparent plastic cross-sections appropriately colored, and ground water information by colored pegs indicating the piezometric surface and artesian conditions.

The model will be very useful in studying and discussing the geologic, hydrologic and engineering problems and their correct solutions as applied to mine operation and reservoir operation in the Metaline Mining District. It is anticipated that a hearing will be held before the Federal Power Commission.

Rescue Teams Ready

Before moving into a simulated disaster area, members of this mine rescue team at the Sullivan mine of Cominco, set a jack post to prevent weak ground from giving way.

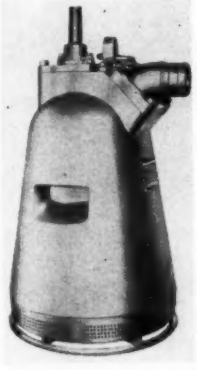
Mine rescue training sessions at the Sullivan mine leave little to the imagination. Complete indoctrination is given in the method of dealing with a variety of emergencies which are possible: fires, cave-ins, explosive gases, flooding and explosions. Intensive training is provided regularly in the use of test instruments, gas masks, oxygen breathing apparatus, and other essential safety equipment.

Typical of preparations made at mining properties throughout the U. S. and Canada, if an accident does occur at the Sullivan mine, despite all safety engineering precautions, rescue teams are ready to "take over" with speed, precision and efficiency.

manufacturers forum

Portable Pumps

FULLY SUBMERSIBLE and operated by electricity, Flygt pumps are now being assembled for the first time in the United States at Hoosick Falls, N. Y., by Stenberg Manufacturing Corp. A Swedish invention, Flygt pumps reportedly can handle a high proportion of solids without difficulty and can be run for long periods without supervision. They require no suction hose or installation. The largest of the Flygt pumps, the 67 hp B-150/200L, weighs 1250 lb and has a capacity of 1500 gpm at a head of 65 ft. The smallest of this series is the B-38L, which weighs 79 lb and has a capacity of ten gpm against a head of 65 ft.



Aluminum Flatbed Trailer

CONSTRUCTED OF HIGH-STRENGTH AIRCRAFT ALLOYS, an aluminum flatbed trailer has been built by Williamsen Body & Equipment Co., Ogden, Utah. Designed by Williamsen, in cooperation with Aluminum Company of America's development division, the 40-ft rig can transport 50,000 lb of concentrated payload. Besides utilizing aluminum structural components, the 7400-lb rig features aluminum in the flooring, fifth wheel plate, and eight forged disc wheels.

Metal Containers for Explosives

TIN PLATE and steel containers have been developed by Vulcan Containers Inc., Bellwood, Ill. These all metal containers are said to insure protection against water for use of ammonium nitrate explosive mixture. Designed for either horizontally or vertically drilled holes, the containers are manufactured in various diameters ranging from 4¼ in. through 10¼ in. The tin plate containers are 16¾ in. in height and have full double friction tops; the steel containers are 24 in. in height and have double seamed tops with a 73-mm opening in the center for filling. All containers have wire carrying grips affixed to electrically welded cleat and reportedly are air tested to insure a leakproof explosive container.

Impact Wrench

HIGH-SPEED PHOTOGRAPHY used in conjunction with an extensive study of tool impacting operations has led to the development of a new impact wrench, according to the Gardner-Denver Co., Quincy, Ill.

The new wrench is available in two models. Both are said to feature light weight and small dimensions, and are rated at ¾ in. nut-setting capacity. Model 18B-7 is equipped with ¾ in. square drive and Model 18B-7S has ⅝-in. built-in hexagon slip chuck. Accessories for the wrench include stud drivers, socket adapters, hexagon shank socket holders and universal joint socket adapters.

Complete information on the impact wrench is available in Bulletin 18-11 from Gardner-Denver Co., Quincy, Ill.

Inquiries about new equipment appearing in Manufacturers Forum are welcomed. For additional information on any piece of equipment in this section write directly to the manufacturer, or to Mining Congress Journal with name of item and date of issue in which it appeared.

Air Motor

DEVELOPED FOR MINING APPLICATIONS, the Dart Manufacturing & Sales Company's air motor is known as Model LAV. It has a normal rating of three hp, although the unit is built to any required specifications upon request, and weighs 36 lb. With the vibrator belt, it is an external vibrator with a range of zero to 10,000 rpm. Without the belt, it becomes a general utility motor, operating pulleys and power take-off systems.

Model LAV has end mountings which adapt to any of the Dart line of concrete vibrators, thus reportedly making it possible to place, consolidate or screen concrete in tunneling jobs, run power equipment or compact with internal vibration safely where electric spark or gasoline operation would be dangerous. The motor can be detached to run a spudder, and the exhaust air at high rpm acts as a circulating blower, reportedly reducing the hazard of explosion from accumulated gases below ground.

For additional information write Dart LAV, P. O. Box 1051, Denver 1, Colo.

Mine Power Controlled by Fan Operation

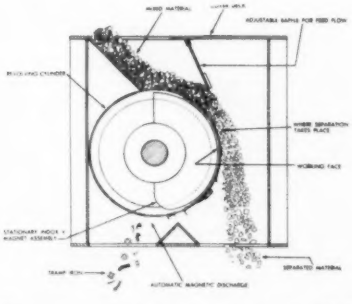
A CONTROL SYSTEM FOR SAFETY in mines employs fan operation to control power. Using a single pair of wires, the system provides automatic opening of circuit breakers from fans and also provides manual or automatic on-off operation of all circuit breakers. From a central control cabinet up to 22 locations, including the fans, may be synchronized in a single system. When any fan stops, all power is removed from the mine automatically. For additional information, write manufacturer: Femco, Inc., Irwin, Pa. Request data on Femco Mine Fan Power Control System.

Pipe Cutter

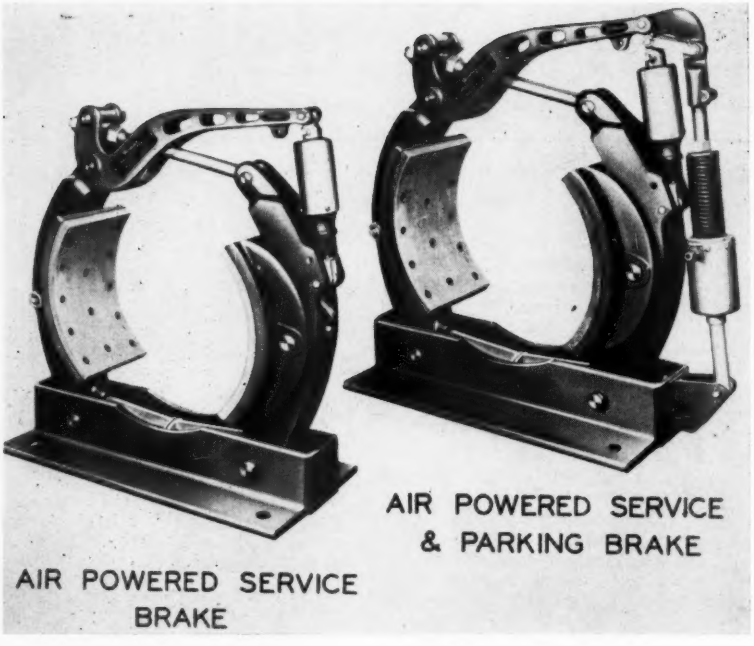
FOR HAND OR POWER DRIVE USE, the Non-Spiral Clear Vue Cutter has extra wide rollers to prevent spiraling and cuts ⅛ to two-in. material. The tool uses the Beaver Honed-Edge Black Magic Cutter Wheel and is manufactured by Beaver Pipe Tools, Inc., Warren, Ohio.

Tramp Iron Separator

A PERMANENT MAGNET DRUM is the latest development in a line of tramp iron separators using Indox V ceramic magnets, according to Stearns



Magnetic Products, 635 South 28th St., Milwaukee 46, Wis. The drum separator is designed for installation in any enclosed chute or spout conveying system and is recommended by the manufacturer for positive tramp iron separation in process industries, or wherever iron particles must be removed from the granular product. The unit requires no energizing current and has a dust-protective enclosure design, permanently lubricated bearings, and a direct drive. It is available in a complete range of standard sizes—with drum diameters from 12 to 24 in.



Industrial Air Brakes

FOR HEAVY INDUSTRIAL EQUIPMENT, two air-braking systems have been developed by Wagner Electric Corp., 6400 Plymouth Ave., St. Louis 14, Mo. Both systems are available with the 14 by 6 in. or the 18 by 8 in. Wagner external shoe type brake. One system is for making service stops only. The brake is applied by an air actuating cylinder which incorporates a return spring for quick release. The second system is for both service stops and for parking and holding operations; in addition to the air actuating cylinder, it incorporates a spring-applied air-released parking cylinder. With the exception of the cylinders, all parts of the brakes are interchangeable with those used on Wagner hydraulic brakes of like size.

Tractors

A LINE OF COMMERCIAL WHEEL tractors in six-power sizes has been announced by International Harvester Co., 180 North Michigan Ave., Chicago, Ill. Smallest of the tractors is the Cub Lo-Boy with an estimated 12.8 engine hp. Next in line is the light-duty International 140 tractor, with an estimated 28 ehp, available with either gasoline or distillate engine. The International 240 tractor, estimated 38 ehp, and the International 340 Utility, estimated 45 ehp, are available with a choice of gasoline, LP Gas, or distillate engines. The International 460 Utility tractor, with an estimated 61 ehp, and the International 560, estimated 72 ehp, workhorse of the industrial line, are equipped with multi-range, six-cylinder gasoline, LP Gas, distillate or diesel engines.

Pulley Lagging

A HIGHLY CONFORMABLE NON-SLIP MATERIAL with a granular surface—originally developed as a floor covering—has been announced for pulley lagging by Minnesota Mining & Mfg. Co., Dept. F8-226, 900 Bush St., St. Paul 6, Minn.

Available as scotch-tred brand Resilient Non-Slip Floor Covering, the material reportedly has the flexibility and pliancy necessary to conform to all types of pulleys, the durability to withstand the rigors of continual stopping and starting, and the ability to grip a conveyor belt without scoring or cutting it.

Detonating Fuse

FOR FIRING INSENSITIVE BLASTING AGENTS, a 175-grain fuse approximately ⅜ in. in diameter has been announced by Austin Powder Co., Cleveland 13, Ohio. The detonating fuse is said to improve the performance of ammonium nitrate powders by increasing their rate of detonation. In many cases, the fuse also eliminates the need for a high explosives primer. Austin detonating fuse is provided with a waterproof, polyethylene coating and reportedly is insensitive to shock, abrasion and stray electrical currents.

Adapter Makes Pump Motors Available

AN HYDRAULIC pump motor adapter which makes General Electric's Tri-Clad '55 a-c motors available as hydraulic pump motors has been announced by General Electric Co., Schenectady, N. Y. The adapter fits on the end shield of the motors and reportedly permits the installation of almost any flange-mounted hydraulic pump directly on the motor. The Tri-Clad '55 motors are available from 7½ to 125 hp and with standard ratings from 600 to 3600 rpm.

Laboratory Flotation Machine

THE MULTI-PURPOSE Mineral Master is a Fagergren batch type flotation machine utilizing interchangeable parts to perform laboratory test work in flotation, agitation, and attrition. All major castings are made of aluminum and the machine may be disassembled into five major components for greater portability. In addition to the two styles of variable pitch sheave drives which were available in the past, the Mineral Master can be equipped with a step cone sheave drive. The air inlet has also been redesigned to facilitate the introduction of gases other than air into the bowl. For more information, contact Western Machinery Co., 650 Fifth St., San Francisco 7, Calif.

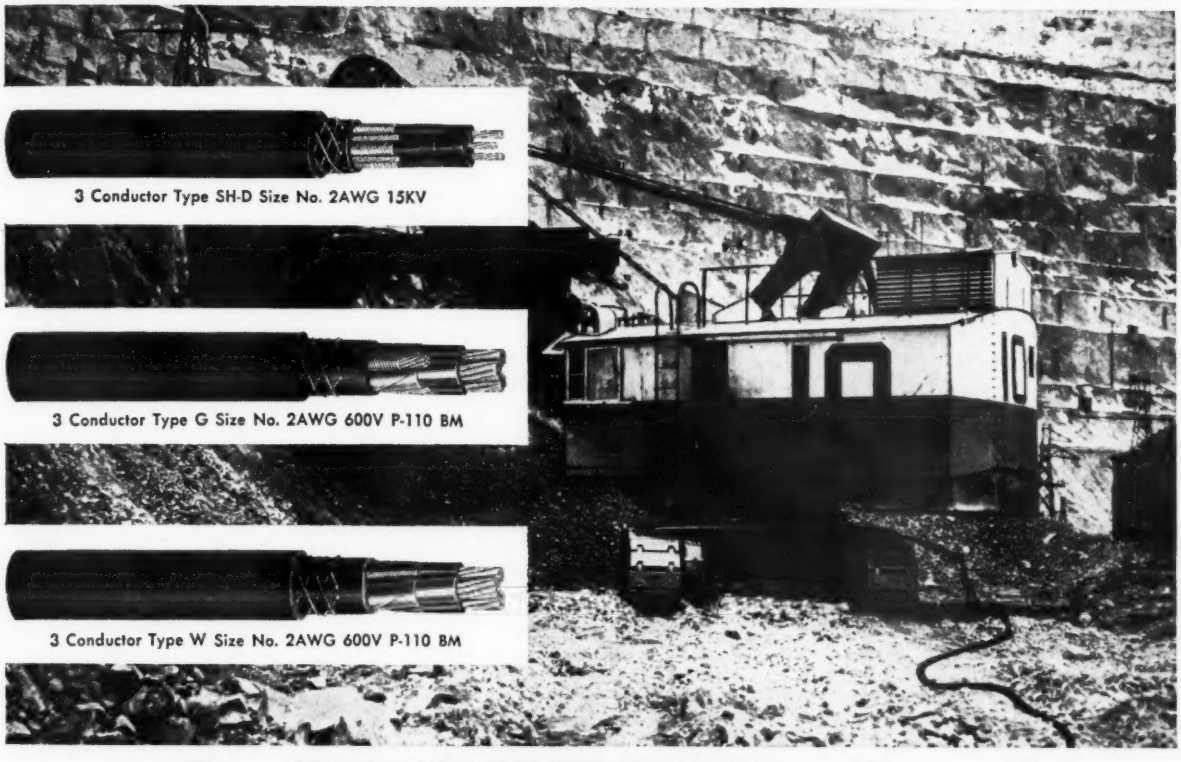
Transmission

A COMBINATION WORM AND PLANETARY GEAR transmission rated at 225 ft lb at 8 rpm output is

now in production by the Merkle-Korff Gear Co., 213 North Morgan St., Chicago 7, Ill. The heat-treated worm of the Model DS is of high carbon alloy steel. The worm gear is of two-piece construction, with the gear portion made with a recently developed bronze alloy. The sun gear is cut from an alloyed grey iron casting containing chromium and vanadium. The planet gears are heat-treated steel. The ring gear is cut integral with the grey iron housing. Model DS has a 220 to 1 ratio, and incorporates a counter-clockwise input and output.

GENERAL CABLE SUPER SERVICE

PORTABLE POWER and MINING CABLE



with SUPERTUF Jacket

GENERAL CABLE offers a complete line of SUPER SERVICE portable power and mining cables which will stand up under the most severe operating conditions and furnish longer life and reliable service no matter how difficult the application.

All SUPER SERVICE cables are jacketed with an extra heavy duty, vulcanized in mold, double layer cord reinforced "SUPERTUF" neoprene sheath with maximum resistance to tearing, cutting, abrasion and overall mechanical abuse, and possessing outstanding resistance to water, oil, acids, alkalis, flame and effects of sunlight and weathering.

SUPERTUF neoprene jacket far exceeds the requirements of ASTM D-752, and all 600 volt SUPER SERVICE portable cables bear the official approval number P-110 BM embossed in the jacket indicating compliance with the flame resistance requirements of the Pennsylvania Department of Mines and requirements of the Federal Bureau of Mines.

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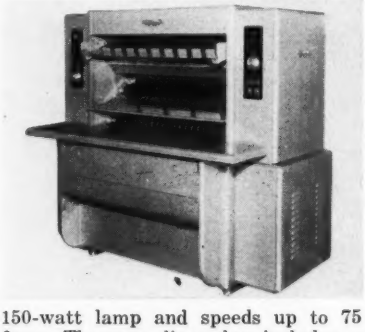
Front End Loader

PRODUCTION OF A FOUR-WHEEL DRIVE 1¾-cu yd front end loader has been announced by the Tractomotive Corp., Deerfield, Ill. The 15,850-lb loader, designated the TL-16 Tractoloader, is said to have a maximum lifting capacity of 14,000 lb and a breakout force of up to 18,-400 lb. Power is provided by either a 101-hp Hercules gasoline engine or a 97-hp Hercules diesel engine. The loader has a 3.5 to 1 torque converter and a three-speed full power shift transmission. In addition, the TL-16 has rear-wheel power steering, four-wheel power brakes, planetary axles, six-way adjustable operator's seat, bucket level indicator, rear-axle disconnect and a fully enclosed hydraulic system.

Whiteprinters

HIGH-SPEED VERSIONS of the Revolute Star Automatic Whiteprinting Machine have been introduced by the Paragon-Revolute Corp., 77 South Ave., Rochester 4, N. Y. The original Star was equipped with an 80-watt lamp and had a top speed of 45 fpm. The new models have either a 100 or



150-watt lamp and speeds up to 75 fpm. The new line also includes a narrow gauge 24-in. model for those who do not require the capacity of larger machines. Features claimed for the new model include a revised cooling system which reportedly assures lower cylinder temperatures even with the new lamps, increased developing capacity, separate feeding belts, an adjustable tracing tray, electronic drive and an air-knife pickoff. For complete details write for brochure No. 1257.

Cabs for Tractor Shovels, Dozers, Loggers

A LINE OF ALL-WEATHER cabs for Michigan 1¼ to 6-cu yd tractor shovels, 162 to 600-hp tractor dozers and 5700 to 20,000-lb capacity tractor loggers has been announced by the Construction Machinery Division, Clark Equipment Co., Pipestone Rd., Benton Harbor, Mich. The all-welded steel cab can be installed in the field. All windows are made of safety glass, set in rubber molding. The rear window is hinged for opening and can be completely removed. The two doors can also be removed. The inside of the cab is sprayed with "muffle-coat" compound to deaden noise.

Electric Power Trucks

A LINE OF EXPLOSION-PROOF electric powered "walkie" type industrial trucks has been announced by the Moto-Truc Co., 1954 East 59th St., Cleveland, Ohio. First of the new design to be built is a towing tractor; however, the same design principles are being adapted to all models built by Moto-Truc.

The truck is designed to meet Underwriters' Laboratories Type Ex-Class 1-Group D specifications. All electrical switches, motors and junctions are sealed in specially designed enclosures. Wiring is contained in armoured conduit. To eliminate the hazards and heat of resistance boxes normally used on this type electric truck, a battery arrangement is employed to permit flexible speed control. The battery itself is completely sealed to avoid the possibility of sparks caused by accidental grounding of connections.

Metering Valve

A THROTTLING valve for general industrial and chemical use is being manufactured by Shaffer Tool Works, Brea, Calif. This metering valve is claimed to have many features which make it ideal for accurate fluid or gas control. Outside threads give corrosion resistance and the stem may be locked at any setting. A pointer and calibration plate indicate the amount of orifice opening. A tapered throat gives a venturi tube effect with reportedly excellent flow characteristics.

Available in ASA or API flanged or threaded connections, the valve is made in carbon steel, stainless steel, bronze or aluminum. It is manufactured in sizes one to six in. and in pressure ratings to 10,000 psi in all sizes. Automatic actuation by hydraulic or air pressure is available on all valves.

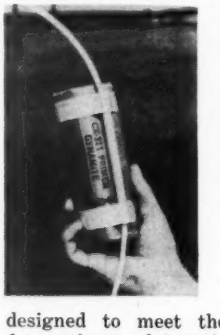
Several interchangeable tips are manufactured: conical, micro tip which gives equal changes of orifice area for equal stem travel, thermo tip which has an internal heating element in the tip, and extra-hard metal tips for special abrasion resistance. Fixed diameter chokes are available in all sizes.

Ore Carrier

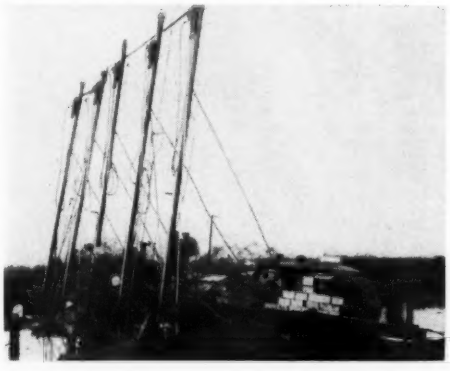
HYDRAULICALLY OPERATED, the model CD-4 Getman Scoot-Crete ore carrier is said to be approved by the United States Board of Mines for underground mining in hardrock and metal mines. The CD-4 carries a load of 85 to 110 cu ft forward and backward and has a turning radium (over-all) of 11 ft 6 in. Over-all length of the unit is 15 ft 6 in., and over-all height, depending on dump box capacity, is 56 in. Powered by a Continental diesel engine, the carrier's speed is from 1 to 15 mph forward or reverse. For more information write Getman Brothers, South Haven, Mich.

Gelatin Explosive

FOR PRIMING LOW-COST BLASTING AGENTS, a high-velocity gelatin explosive is being offered by the explosives and mining chemicals department of American Cyanamid Co., 30 Rockefeller Plaza, New York 20, N. Y. This product, CX-311 Primer, reportedly is designed to meet the requirements for optimum detonation of free-running blasting agents in quarrying, construction, stripping and open-pit mining. The cartridge is 2½ in. in diameter and 6 in. in length, and each unit weighs approximately 1½ lb. The company developed this product and package specifically for priming ammonium nitrate (fertilizer grade) and Accomite blasting agent.

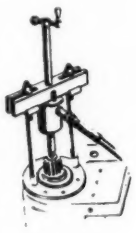


Special Drill Buggy for Everglades

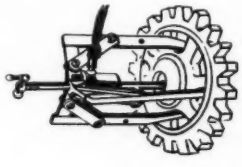


TO DRILL 11 MILES OF CANAL through the muck of Florida's Everglades, Clemens Construction Co. had to build a special drilling rig. Seven hollow steel wheels, five ft in width and seven ft in diameter, support a platform which mounts five Ingersoll-Rand rock drills and two I-R Gyro-Flo 600 cfm rotary air compressors. The large unit is maneuvered by two Ingersoll-Rand air motors geared to two of the wheels.

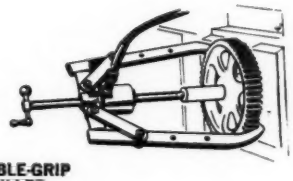
Hydraulic Pulling Equipment



PUSH-PULLER



TRIPLE-GRIP PULLER



DOUBLE-GRIP PULLER

A SERIES OF PULLERS, double and triple-grip; push-pullers; and attachments have been added to the Simplex line of hydraulic jack equipment. These units are available separately or complete with Re-Mo-Trol hydraulic centerhole rams and pumps in 20 and 30-ton capacities. They are designed for removing and installing gears, pulleys, wheels, bearings, bearing sprockets and cups, and axles on practically all types of equipment. For complete information write to Templeton, Keney & Co., 2535 Gardner Rd., Broadview, Ill.

—*Announcements*—

H. Hadley Merritt has been appointed service manager of **National Mine Service Company's** equipment division. He will supervise all service work on the National Mine Tor-Kar, a-c, d-c, and diesel shuttle cars.

At the same time the company announced that its executive offices had been moved from the Alcoa Building to new quarters in the Koppers Building in Pittsburgh.

The board of directors of **Lake Shore, Inc.**, has announced the election of **B. W. Reeve** to the office of president succeeding the late **F. A. Flodin.**

Rudolph C. Gebhardt, geologist and mining engineer, has been named manager of the mining division of the **E. J. Longyear Co.** He succeeds **Donald M. Davidson**, who became president of the company July 1.

Election of **J. C. Mabe**, vice president in charge of plant operations, to the board of directors of the **Chicago Pneumatic Tool Co.** has been announced.

The appointment of **Harry J. Dempsey, Jr.** as sales manager of **Easton Car & Construction Co.** has been announced. Dempsey was formerly manager—New York District, handling regional and export sales.

Raymond E. Byler has been appointed manager of research and development by the **Western Machinery Co.** Former business manager for the western division of **Arthur D. Little, Inc.**, he will play a key role in Western Machinery's greatly expanded research and development work in chemical and metallurgical equipment and processes.

CATALOGS & BULLETINS

TORQUE FLUID. *D-A Lubricant Co., Inc., Indianapolis 23, Ind.* The illustrated folder describes the use of D-A Torque Fluid in heavy-duty automatic transmission, torque converters, rotary air compressors and hydraulic systems.

PORTABLE POWER FLARER. *W. D. Wynant, Parker Fittings & Hose Division, Parker-Hannifin Corp., 17325 Euclid Ave., Cleveland 12, Ohio.* Descriptive catalog sheet No. 1145A15 describes the Parker "Portaflare" tool—a portable, motor-driven unit for flaring tubing in the shop, in the mine or in the field. The tool flares fully annealed steel and stainless steel hydraulic tubing, as well as tubing of other materials, in sizes from ¼ to ¾ in. outside diameter and in wall thicknesses up to ten per cent of tube diameter. Individual ballcones are used for each size and wall thickness of tube.

FILM ON DENSE MEDIA PROCESS. *Western Machinery Co., 650 Fifth St., San Francisco 7, Calif.* "Float Your Troubles Away," a movie showing the heavy media process for removing unsound or deleterious particles from gravel, uses case histories at three plants to illustrate the Wemco Mobil-Mill and its applications. Available for showing to all interested groups, the movie is said to be an invaluable guide to the gravel producer desiring to know whether HMS can help him produce the quality product required by today's higher concrete specifications.

SELF-DUMPING HOPPERS. *Apex Welding & Fabricating Corp., 30 Interstate St., Bedford, Ohio.* Brochure illustrates and describes a line of self-dumping hoppers. Engineered for industrial truck handling, the hoppers reportedly can be used for wet or dry materials, either hot or cold. The hoppers may be automatically dumped by releasing a gravity cam latch. After a load is dumped, the unit rights itself and locks in the closed position. The literature describes the five models available with capacities from one-half to two yd.

EQUIPMENT USED IN AGGREGATE PRODUCTION. *Wemco Products Division, Western Machinery Co., 650 Fifth St., San Francisco 7, Calif.* The 40-page book, Bulletin G7-B25, discusses methods of aggregate preparation, beneficiation and handling and is illustrated with charts, working drawings, and photographs describing the use of Wemco equipment in the aggregate industry. Complete engineering data is given for ten Wemco machines used in aggregate production.

CARBIDE MINING TOOLS. *Allegheny Ludlum Steel Corp., Carmet Division, Ferndale, Detroit 20, Mich.* A revised catalog entitled "Carmet Carbide Mining Tools," the 20-page booklet lists all the standard mining tools now being manufactured by Carmet. Such information as style, rake angle, photographs, and a brief description of the tool and where it can best be used is given. A brief section on the reconditioning procedures, with detailed drawings on the reconditioning of various bits and drills, is also shown.

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PLASTIC STEEL REPAIR KIT. *Devcon Corp., Danvers, Mass.* Bulletin describes Devcon Corporation's Plastic Steel Emergency Repair Kit. In addition to discussing the chemical and physical properties of this product, illustrated case history type applications are also covered.

AIRBORNE PARTICULATE SAMPLERS. *Nucelonic Corporation of America, 196 Degraw St., Brooklyn 31, N. Y.* Bulletin N-31 describes the high-volume airborne particulate sampler, which collects and measures radioactive or non-radioactive dusts, chemicals and other pollutants from atomic plants, reactors, bomb tests, incinerators, isotope labs, manufacturing plants, and mining operations. Air sampler Model HAS-4 is built around a turbine-type blower and inhales at a rate up to 75 cfm, as measured by a self-contained variable orifice meter.

SEMI-AUTOMATIC WELDER. *Wall Colmonoy Corp., 19345 John R St., Detroit 3, Mich.* The brochure points out and illustrates major construction features of the Colmony Semi-Automatic Welder and lists a variety of typical applications in representative industries. Tube wires available for use with the Colmony unit are also described in the new literature.

STEEL BUILDINGS IN COLOR. *Stran-Steel Corp., Detroit 29 Mich.* Complete details on the recent development of pre-engineered steel buildings in color, using a new vinyl-aluminum protective coating, is contained in a brochure entitled "Stran-Steel Buildings in Factory-Applied Stran-Satin Color."

PRESSURE REDUCING VALVES. *Jordan Industrial Sales Division of OPW Corp., 6013 Wiehe Road, Cincinnati 13, Ohio.* Handwheel and ball bearing adjusting screw assembly, complete with finger-operated teardrop lock nut, are now standard equipment on all OPW-Jordan piloted pressure reducing valves; and optional on pressure reducing valves. Besides allowing setting of control pressure without tools, the ball bearing movement is said to eliminate torque force on the main spring, allowing more accurate regulation. Valves are available in ½ to 2½ in. sizes, 250 psi bronze, and 125 psi iron. Write for Bulletins J-160, J-1160, and SRB 29-58.

TANK WEIGHING SYSTEMS. *The A. H. Emery Co., Pine St., New Canaan, Conn.* Covering Emery hydraulic tank weighing systems, Bulletin 581 shows the equipment available to team up with Emery Load Cells in providing indication, recording, printing and controlling in tank weighing installations. A feature of the bulletin is a questionnaire and sketch sheet designed to facilitate the application of the cells to the job at hand.

IN-LINE HELICAL GEAR DRIVES. *Link-Belt Co., Dept. PR, Prudential Plaza, Chicago 1, Ill.* Folder 2651A, a six-page supplement to Link-Belt Book 2651, contains data on horsepower ratings, dimensions, mounting information and a resume of construction principles applying to the quadruple reduction speed reducers. This supplement also contains information on two sizes of double reduction and three sizes of triple reduction helical gear drives in addition to the five sizes of quadruple reduction gear drives.

CUTTING TORCHES. *Linde Co., Division of Union Carbide Corp., 30 East 42nd St., New York 17, N. Y.* Form 1174 describes and illustrates a line of Oxweld flame-cutting equipment. Torches that can be used interchangeably with every fuel gas combination—oxy-acetylene, oxy-propane and oxy-natural gas—are covered. The folder discusses manual and machine-cutting equipment for use on flame-cutting jobs from thinnest sheet metal to risers ten-ft thick. A representative sample of the more than 400 different Oxweld nozzles is also covered.

WORM GEAR DRIVE. *Cleveland Worm & Gear Co., 3249 East 80th St., Cleveland 4, Ohio.* Entitled "Why Worm Gear? Why Cleveland?", Bulletin 150, provides information on worm gearing in general, points out the advantages of this type of gearing and gives pertinent design and manufacturing facts.

ELECTRICAL DISTRIBUTION MATERIALS. *Ohio Brass Co., Mansfield, Ohio.* Publication No. 1396-H features all types of O-B insulators and hardware commonly used on electrical distribution systems. The booklet includes information on the Cooline L-W and Universal No. 88500 deadend clamps, the distribution line post insulator, and wider conductor grooves for small pintype insulators.

ELECTRON MICROSCOPE. *Instruments Division, Phillips Electronics, Inc., 750 South Fulton Ave., Mount Vernon, N. Y.* Containing engineering information on the Norelco EM-100B Electron Microscope, the folder covers construction details, electron optical system, electron source, condenser lens, objective lens and intermediate lens systems.

Index to Advertisers

Here's Why Bucyrus-Erie Dragline Buckets

STRIP FASTER... LAST LONGER

This Model 1250-B uses a 33-cu. yd. bucket on a 200-ft. boom in stripping operations at Hanover, Pennsylvania. Machine is owned by Pennweir Construction Company, a subsidiary of Weirton Construction Co., Weirton, Pa.

Bucyrus-Erie dragline buckets are lighter and stronger because they are made with a specially-developed steel alloy called BECOLOY. It has a tough, fibrous structure that withstands shocks of great force . . . has high resistance to abrasion, high load-carrying strength!

BUCYRUS-ERIE buckets are balanced to carry loads smoothly without bobbing and spilling. Your operators can swing through each cycle faster to increase stripping production and profits.

Bucyrus-Erie buckets have BECOLOY in teeth, bucket lip, arch, clevis plate, and chains — the high wear parts of your dragline bucket!

FIND OUT NOW how you can increase both your production and profit with a new Bucyrus-Erie dragline bucket. They're available in light, medium, and heavy-duty types, solid or perforated. Call or write your nearest distributor today. Let him help you choose the right bucket to give your dragline extra output ability. Bucyrus-Erie Company, South Milwaukee, Wis.

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BECOLOY *makes the difference!* BUCYRUS ERIE

Constant and combined research at the MSA and Edison Laboratories determines the quality components of Edison Electric Cap Lamps and charging equipment. This team helps to improve battery performance, increase headpiece light output, and develop efficient charging methods.

Built-in → quality here

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This miner gets dependable full shift illumination from the two equally rated filaments of the Edison R-4 bulb. No lost time, no lost production due to bulb burnouts underground.

Edison R-4 Cap Lamps give mine operators more productive man-hours

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We'd like to talk with you about these costs—hidden downtime costs—and the role the Edison R-4 Electric Cap Lamp plays in reducing them.

There are a number of advantages inherent with the R-4 Lamp which we'd like you to consider. Such things as amount of reserve working light available, long and dependable battery life, choice of self-service charging systems, positive watering method, maintenance-free storage, and prompt service in all mining areas.

An MSA representative will be pleased to present this entire story to you. A practical demonstration can be arranged at your convenience. Write us for details.

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